# A PROGRAM FOR STORING OCEANOGRAPHIC DATA ON MAGNETIC TAPE

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A program has been written for the storage of navigation, bathymetry, and magnetics data on magnetic tape in BCD form. This eliminates the problem of storing vast amounts of data collected on computer cards by oceanographic and geophysical cruises. This program uses a slightly modified format recommended by the National Research Council of the National Academy of Sciences. The program was written in Fortran IV for use on the CDC 3800; however the program can be converted to run on other systems with little difficulty.

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# A PROGRAM FOR STORING OCEANOGRAPHIC DATA ON MAGNETIC TAPE

## 1.0 IDENTIFICATION

### 1.1 Title

Storage Program for Navigation, Bathymetric, and Magnetics Data on Magnetic Tape.

### 1.2 Identification Name

GEODATA.

### 1.3 Classification Code

None.

### 1.4 NRL Research Computation Center Identification Number

None.

### 1.5 Entry Points

GEODATA.

### 1.6 Programming Language

Language: CDC 3600/3800 Fortran.
Routine Type: Program.
Operating System: Drum Scope 2.1.

### 1.7 Computer and Configuration

CDC 3800.

### 1.8 Contributor or Programmer

Marilyn L. Blodgett, Code 4223MB, Research Computation Center, written for Environmental Sciences Section, Acoustics Division.

### 1.9 NRL — Naval Research Laboratory, Washington, D.C. 20375.

NOTE: Manuscript submitted January 9, 1975.

### 1.10 Program Availability

If supplied with a magnetic tape, a copy of this program will be made available by the Environmental Sciences Section, Acoustics Division.

### 1.11 Verification

This program has been used and tested by the Environmental Sciences Section, Acoustics Division, for the past year.

### 1.12 Date

July 1974.

## 2.0 PURPOSE

### 2.1 Description of the Routine

This program transfers the data collected by an oceanographic or geophysical experiment to magnetic tape. The program will take up to 3000 navigational data points and an unlimited number of bathymetric and magnetic data points. The program is set up so that if one tape is filled, any number of continuation tapes can be used. The data tape will have one logical record (of 80 characters) for each data point. The different types of data (navigational, bathymetric, and magnetics) will be separated by an end-of-file mark, with a double end-of-file mark at the end of all the data.

#### 2.1.1 Navigation Data

This program is presentiy set up to read the navigation data from cards. The data are in degrees, minutes, and hundredths of a minute; each navigation fix has an associated Julian date and time (24-hour clock). The southern latitudes and the western longitudes are preceded by a minus sign. Thi. program changes the Julian date to month and day and changes the minutes and hundredths of minutes of latitude and longitude to ter thousandths of a degree.

#### 2.1.2 Bathymetry Data

The bathymetry data are read in with the Julian date followed by five time-depth groups to a card. Time is read to tenths of a minute. The depth can be either uncorrected fathoms or uncorrected meters, but not both in the same run. This program converts the Julian date to month and prints out uncorrected fathoms, uncorrected meters, corrected meters, and Matthews zone. The uncorrected meters are not written on the data tape.

#### 2.1.3 Magnetics Data

The magnetics data are read in with the Julian date, then the hour, followed by 12 magnetic data points (one every five minutes). The program converts the Julian date to month and day and converts the total magnetic intensity in gammas (the data read in) to residual magnetic intensity using the International Geomagnetic Reference Field formula.

#### 2.1.4 Gravity Data

This program is not set up to take gravity data, but a gravity subroutine could easily be inserted.

### 2.2 Problem Background

The rapid accumulation of many boxes of oceanographic data on computer cards necessitated the transfer of the data from cards to magnetic tape. It was decided that the format recommended by the National Research Council of the National Academy of Sciences would be used with one slight modification, the addition of a fix number with the navigation.

## 3.0 USAGE

### 3.1 Calling Sequence or Operational Procedure

Not applicable.

### 3.2 Arguments, Parameters, and/or Initial Conditions

Not applicable.

### 3.3 Space Required (Decimal and Octal)

#### 3.3.1 Unique Storage

36533 Octal (15707 decimal) locations exclusive of system library functions.

#### 3.3.2 Common Blocks

None.

#### 3.3.3 Temporary Storage

None.

### 3.4 Messages and Instructions to the Operator

None.

## 3.5 Error Returns, Messages, and Codes

Deck set up incorrectly.
More than 3000 navigation data cards.
Unable to interpolate latitude and longitude.

## 3.6 Informative Messages to the User

None.

## 3.7 Input

Input parameters and data are read in via punched cards. The format statements can easily be changed to meet requirements of the user. See Appendix A for samples of our data formats. Each data type (navigation, bathymetry, magnetics) are bracketed by a control card with a negative number in columns 1 and 2. The control card preceding the data sets up the different options available. Appendix B is a complete description of the input setup.

## 3.8 Output

The program prints out on the standard printer (logical unit 61) the ship and cruise identification, number of cards read, number of logical records written for navigation, bathymetry, and magnetic data. There is an option for listing all the records written on the output tape and for punching out cards. Appendix C shows samples of the output.

## 3.9 Formats

Appendix B shows the program deck structure.

## 3.10 External Routines and Symbols

SKIPFILE, BACKFILE, XMØDF, SQRTF, SINF, CØSF.

## 3.11 Timing

This program will process approximately 1300 data points a minute. If a listing of all processed data is required, each data point will generate one line. Consequently, this program can process a great deal of data in little time but also produce large printouts.

## 3.12 Accuracy

Not applicable.

## 3.13 Cautions to Users

None.

3.14 Program Deck Structure

See Appendix B.

3.15 References — Literature

"Formats for Marine Geophysical Data Exchange," National Academy of Sciences, June, 1972.

## 4.0 METHOD OR ALGORITHM

Not applicable.

## 5.0 FLOW CHART AND/OR SOURCE LANGUAGE LISTING

Flow chart and listing are given in Appendix D.

## 6.0 COMPARISON

There are no other known programs available for comparison.

## 7.0 TEST METHOD AND RESULTS

A sample of the three types of records written on the output tape are included in Appendix C.

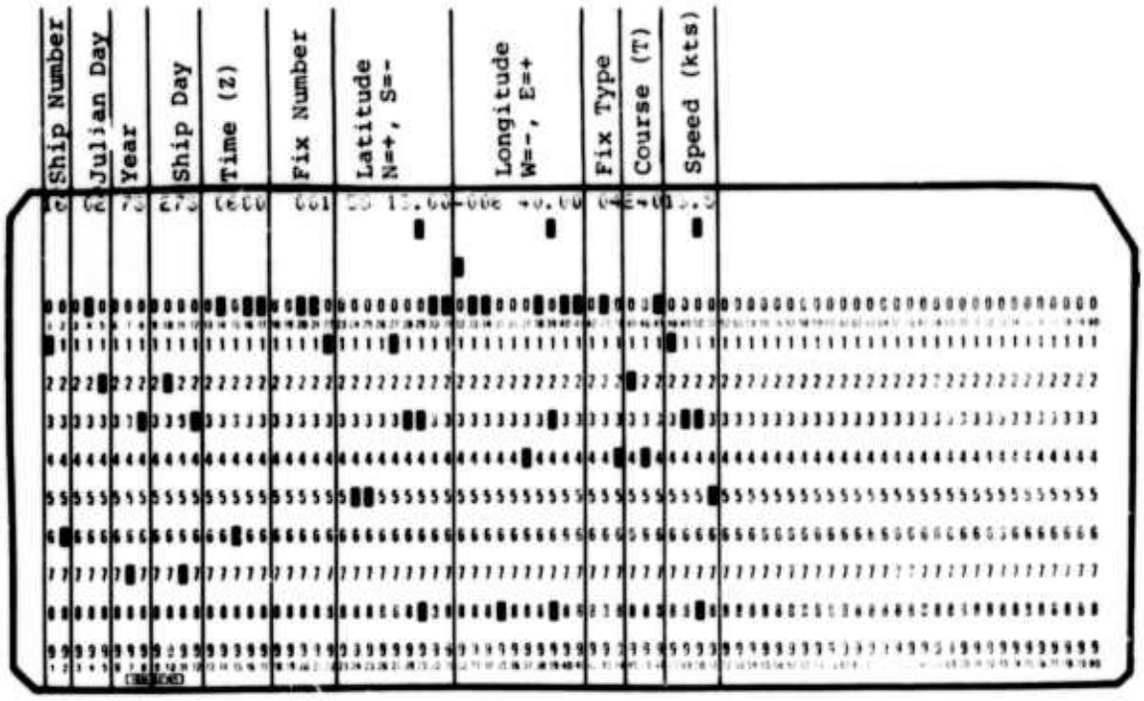
## 8.0 REMARKS

The authors thank Gary Flenner for his review of this report and Wayne Worsley for preparing the illustrations in the appendixes. The authors also thank Leon LaLumiere for providing some of the subroutines used by this program.

## Appendix A

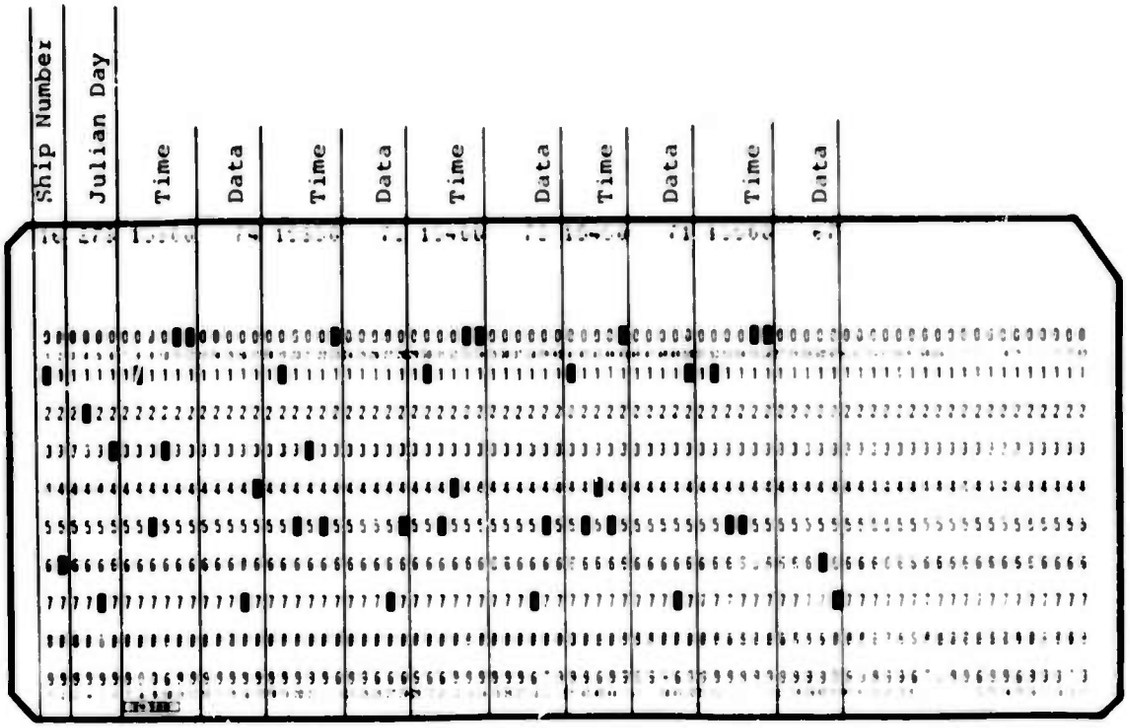
## SAMPLE INPUT DATA CARDS

### NAVIGATION INPUT FORMAT



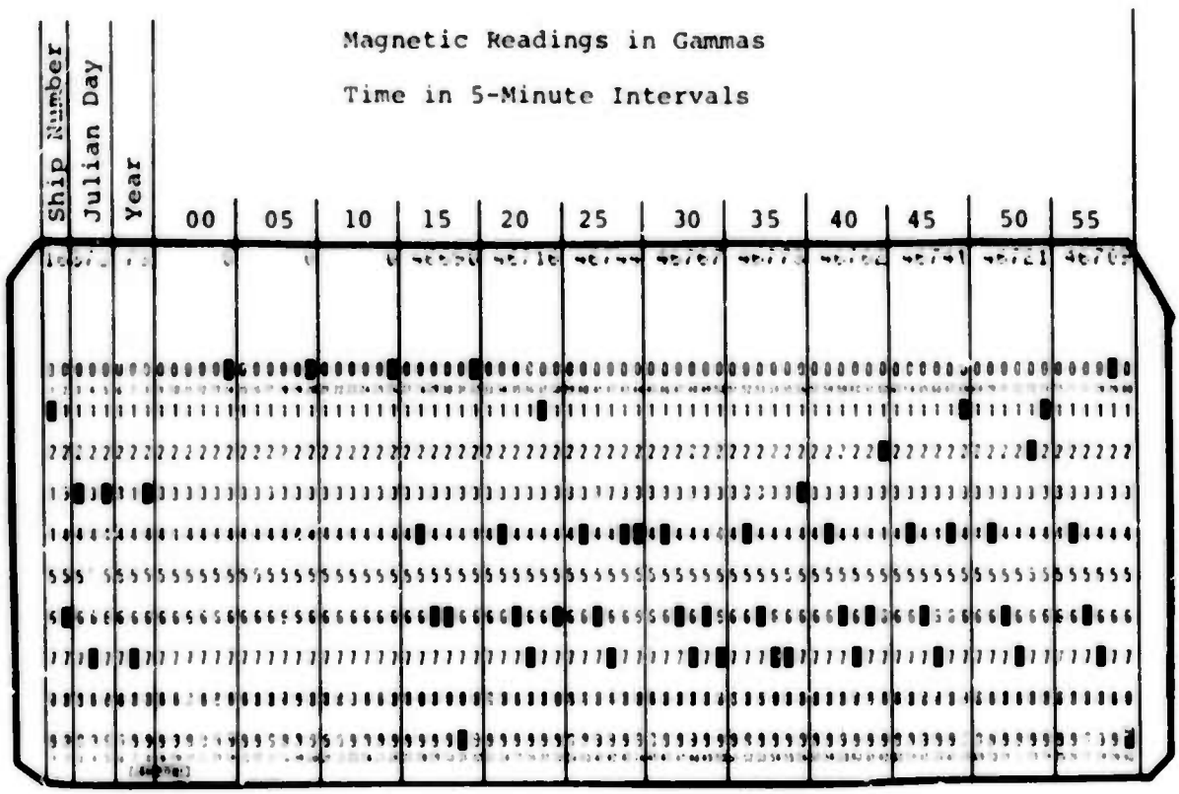

```
108 READ (60,101)ISN,IY,JUDY,RNHR,RNMIN,IFN,XLAD,XLAM,XLOD,XLOM,IFIXTY
101 FORMAT (I2,4XI2,1X,3X13,1XF2,F2,I5,F3,F6.2,F4,F6.2,1XI2)
```

## Bathymetry Input Format




```
205 READ (60,204) ISN,JUDY,(BHR(I),BMIN(I),IDP(I),I=1,5)
204 FORMAT (I2,1XI3,5(1XF2,F3.1,1X14))
```

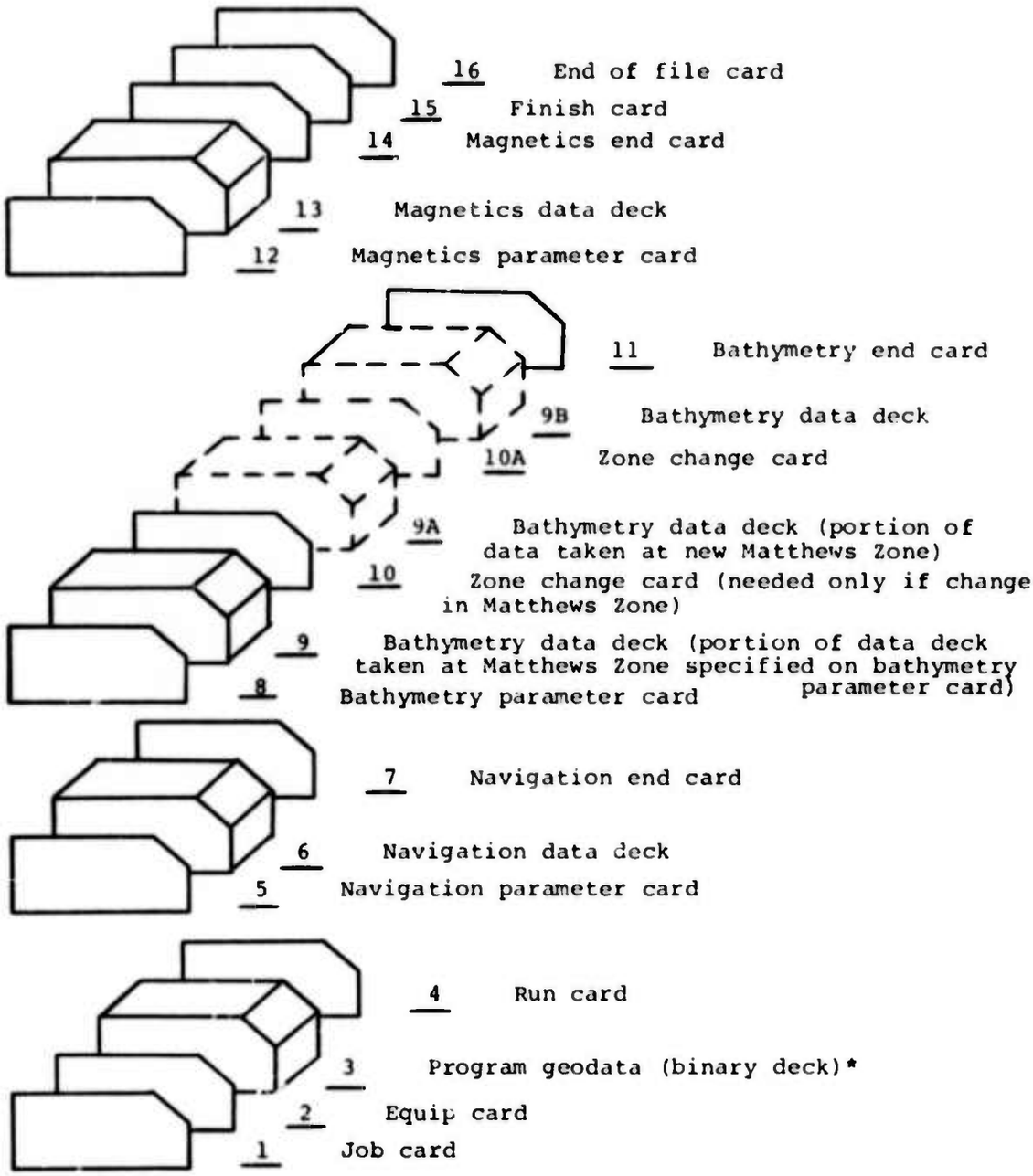
# MAGNETICS INPUT FORMAT




```
302 READ (60,304) ISN,JUDY,RMHR,(IMG(I),I=1,12)
304 FORMAT (I2,I3,1XF2,12(1XI5))
```

## Appendix B

## DECK ASSEMBLY




*If the FORTRAN source deck is used instead of the binary deck, a FORTRAN card is required after the Equip card. The FORTRAN card reads--7/9 FTN, L, R, X. In addition a SCOPE card with SCOPE starting in column 10 and a LOAD card which reads 7/9 LOAD must follow the source deck.

| Number | Card Title | Column Number | Description |
|---|---|---|---|
| 1 | Job | 1-21 | 7/9 JOB, charge No., ID No., time. The charge number consists of alphanumeric characters of any length. The ID number is the programmer identification; it may be any length and appears as given in the control card listing. The time is the maximum time limit in minutes for the entire job. See page 2-2 of the 3600/3800 Computer Systems Drum Scope Manual. |
| 2 | Equip | 1-18 | 7/9 EQUIP, 10 = **, WO, HI<br>10 = logical unit number.<br>WO = write only.<br>HI = high density. |
| 3 | Program GEODATA | Deck of cards | This is the main program with associated subroutines. If the Fortran source deck is used instead of the binary deck, a Fortran card is required after the Equip card. The Fortran card reads 7/9 FTN, L, R, X. In addition a Scope card with SCOPE starting in column 10 and a LOAD must follow the source deck. |
| 4 | Run | 1-13 | 7/9 RUN, T, P, R, M, D<br>T = time limit in minutes.<br>P = maximum number of print or write operations. R, M, D may be left blank. See page 2-15 of the 3600/3800 Computer Systems Drum Scope Manual. |
| 5 | Navigation Parameter | 1-2 | −1<br>This number designates the Navigation Parameter card. |
| | | 5 | 0, 1, 2<br>0 = write the navigation data on a new tape.<br>1 = read the navigation data cards and store the information necessary for interpolation. The program will not write the navigation data on the tape. It will only write the bathymetry data on a tape that already contains the navigation and magnetic data. |

| Number | Card Title | Column Number | Description |
|---|---|---|---|
| | | | 2 = Read the navigation data cards and store the information necessary for interpolation. The program will not write the navigation data on the tape. It will only write the magnetics data on a tape that already contains the navigation and bathymetry data. |
| | | 19-20 | 0, 1, 2, 3<br>0 = just write the navigation data on tape in the required format.<br>1 = write the navigation data on tape and print out a listing of the data.<br>2 = write the navigation data on tape and punch out a card for each logical record written on the tape.<br>3 = write the navigation data on tape and print out a listing. In addition, punch out a card for each logical record written on the tape.<br>If card columns 4-5 are 1 or 2, more of the options in card columns 19-20 are available. |
| | | 23-30 | Columns 23-30 are for cruise identification. Any eight-digit alphanumeric number may be used. |
| 6 | Navigation Data Deck | | Place the Navigation Data Deck after the Navigation Parameter card. |
| 7 | Navigation End | 1-2 | −5<br>This number designates the end of the Navigation Data Deck. |
| 8 | Bathymetry Parameter | 1-2 | −2<br>This number designates the Bathymetry Parameter card. |
| | | 4-5 | Columns 4-5 are for the Matthews zone. |
| | | 14-15 | 1 or 2<br>1 = Depth data in uncorrected fathoms.<br>2 = Depth data in uncorrected meters. |

| Number | Card Title | Column Number | Description |
|---|---|---|---|
| | | 19-20 | 0, 1, 2, or 3<br>0 = just write the bathymetry data on tape in the required format.<br>1 = write the bathymetry data on tape and print out a listing of the data.<br>2 = write the bathymetry data on tape and punch out a card for each logical record written on the tape.<br>3 = write the bathymetry data on tape and print out a listing. In addition punch out a card for each logical record written on the tape. |
| 9 | Bathymetry Data Deck | | Place that portion of the Bathymetry Data Deck which was taken at the Matthews zone specified on the Bathymetry Parameter card after the Bathymetry Parameter card. |
| 10 | Zone Change | 1-2 | −6<br>This number designates a change in the Matthews zone. A Zone Change card must precede the first data card taken at the new Matthews zone. These Zone Change cards can be scattered throughout the Bathymetry Data Deck. |
| | | 4-6 | Value of the new Matthews zone. |
| 11 | Bathymetry End | 1-2 | −7<br>This number designates the end of the Bathymetry Data Deck. |
| 12 | Magnetics Parameter | 1-2 | −3<br>This number designates the Magnetics Parameter card. |
| | | 6-10 | Height in feet above or below mean sea level. |
| | | 19-20 | 0, 1, 2, or 3<br>0 = just write the magnetics data on tape in the required format.<br>1 = write the magnetics data on tape and print out a listing of the data. |

| Number | Card Title | Column Number | Description |
|---|---|---|---|
| | | | 2 = write the magnetics data on tape and punch out a card for each logical record.<br>3 = write the magnetics data on tape and print out a listing. In addition, punch out a card for each logical record written on the tape. |
| 13 | Magnetics Data Deck | | Place the magnetics data deck after the magnetics parameter card. |
| 14 | Magnetics End | 1-2 | −8<br>This number designates the end of the Magnetics Data Deck. |
| 15 | Finish | 1-2 | −4<br>This number designates the end of all data. |
| 16 | End-of-File | | |

## Appendix C1

## SAMPLE OUTPUT LISTINGS

# SAMPLE NAVIGATION PRINTOUT

| SHIP AND CRUISE IDENTIFICATION | TIME ZONE | YEAR | MONTH | DAY | HOUR | MINUTE | LATITUDE | LONGITUDE | FIX DESCRIPTION | FIX NUMBER |
|---|---|---|---|---|---|---|---|---|---|---|
| 73-16-02 | 0 | 73 | 8 | 22 | 10 | 6.0 | 72.7287 | -10.3975 | 50 | 200 |
| 73-16-02 | 0 | 73 | 8 | 22 | 10 | 40.0 | 72.7710 | -10.3330 | 50 | 201 |
| 73-16-02 | 0 | 73 | 8 | 22 | 10 | 50.0 | 72.7850 | -10.3167 | 49 | 202 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 0.0 | 72.7993 | -10.2895 | 50 | 203 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 30.0 | 72.8333 | -10.2253 | 50 | 204 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 54.0 | 72.8647 | -10.1642 | 50 | 205 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 20.0 | 72.9088 | -10.0868 | 50 | 206 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 48.0 | 72.9333 | -10.0395 | 50 | 207 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 14.0 | 72.9685 | -9.9792 | 50 | 208 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 37.0 | 72.9983 | -9.9188 | 49 | 209 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 14.0 | 73.0460 | -9.8135 | 50 | 211 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 34.0 | 73.0708 | -9.7570 | 50 | 212 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 0.0 | 73.1072 | -9.6877 | 49 | 213 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 28.0 | 73.1255 | -9.6198 | 50 | 214 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 47.0 | 73.1375 | -9.5817 | 49 | 215 |
| 73-16-02 | 0 | 73 | 8 | 22 | 16 | 2.0 | 73.1718 | -9.5027 | 50 | 216 |
| 73-16-02 | 0 | 73 | 8 | 22 | 16 | 46.0 | 73.2778 | -9.2473 | 50 | 218 |
| 73-16-02 | 0 | 73 | 8 | 22 | 17 | 14.0 | 73.3527 | -9.0855 | 50 | 219 |
| 73-16-02 | 0 | 73 | 8 | 22 | 17 | 48.0 | 73.4387 | -8.8817 | 50 | 220 |
| 73-16-02 | 0 | 73 | 8 | 22 | 18 | 5.0 | 73.4817 | -8.7667 | 49 | 221 |
| 73-16-02 | 0 | 73 | 8 | 22 | 18 | 8.0 | 73.4865 | -8.7435 | 50 | 222 |
| 73-16-02 | 0 | 73 | 8 | 22 | 18 | 28.0 | 73.5247 | -8.6728 | 50 | 223 |
| 73-16-02 | 0 | 73 | 8 | 22 | 19 | 8.0 | 73.5942 | -8.4753 | 50 | 225 |
| 73-16-02 | 0 | 73 | 8 | 22 | 19 | 32.0 | 73.6428 | -8.3643 | 50 | 226 |
| 73-16-02 | 0 | 73 | 8 | 22 | 19 | 52.0 | 73.6785 | -8.2742 | 50 | 227 |
| 73-16-02 | 0 | 73 | 8 | 22 | 20 | 14.0 | 73.7192 | -8.1853 | 50 | 229 |
| 73-16-02 | 0 | 73 | 8 | 22 | 20 | 34.0 | 73.7575 | -8.0848 | 50 | 230 |
| 73-16-02 | 0 | 73 | 8 | 22 | 21 | 16.0 | 73.8378 | -7.9065 | 50 | 231 |
| 73-16-02 | 0 | 73 | 8 | 22 | 21 | 38.0 | 73.8803 | -7.8202 | 50 | 232 |
| 73-16-02 | 0 | 73 | 8 | 22 | 22 | 4.0 | 73.9320 | -7.7025 | 50 | 233 |
| 73-16-02 | 0 | 73 | 8 | 22 | 22 | 28.0 | 73.9720 | -7.6172 | 50 | 234 |
| 73-16-02 | 0 | 73 | 8 | 22 | 23 | 0.0 | 74.0432 | -7.4810 | 50 | 235 |
| 73-16-02 | 0 | 73 | 8 | 22 | 23 | 22.0 | 74.0803 | -7.3897 | 50 | 236 |
| 73-16-02 | 0 | 73 | 8 | 22 | 23 | 50.0 | 74.1463 | -7.2443 | 50 | 237 |
| 73-16-02 | 0 | 73 | 8 | 23 | 0 | 10.0 | 74.1880 | -7.1523 | 50 | 238 |
| 73-16-02 | 0 | 73 | 8 | 23 | 0 | 44.0 | 74.2580 | -6.9860 | 50 | 239 |
| 73-16-02 | 0 | 73 | 8 | 23 | 1 | 4.0 | 74.3000 | -6.8735 | 50 | 240 |
| 73-16-02 | 0 | 73 | 8 | 23 | 2 | 6.0 | 74.4165 | -6.5770 | 50 | 241 |
| 73-16-02 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0000 | 0.0000 | 0 | 0 |
| 73-16-02 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0000 | 0.0000 | 0 | 0 |

# Sample Bathymetry Printout

| SHIP AND CRUISE IDENTIFICATION | TIME ZONE | YEAR | MONTH | DAY | HOUR | MINUTE | LATITUDE | LONGITUDE | UNCORRECTED FATHOMS | UNCORRECTED METERS | CORRECTED METERS | PATTHI TAPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73-10-02 | 0 | 73 | 8 | 22 | 10 | 90.0 | 72.7588 | -10.3520 | 1440.8 | 2638.0 | 2642 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 10 | 95.0 | 72.7649 | -10.3425 | 1448.4 | 2648.0 | 2657 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 10 | 40.0 | 72.7710 | -10.3330 | 1453.4 | 2658.0 | 2668 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 10 | 45.0 | 72.7780 | -10.3248 | 1459.9 | 2670.0 | 2678 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 10 | 90.0 | 72.7850 | -10.3167 | 1467.4 | 2684.0 | 2692 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 10 | 95.0 | 72.7902 | -10.3031 | 1473.0 | 2694.0 | 2707 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 0.0 | 72.7953 | -10.2895 | 1479.1 | 2705.0 | 2714 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 5.0 | 72.8017 | -10.2788 | 1482.9 | 2712.0 | 2721 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 10.0 | 72.8080 | -10.2681 | 1487.5 | 2720.0 | 2729 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 15.0 | 72.8143 | -10.2574 | 1492.7 | 2730.0 | 2739 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 90.0 | 72.8207 | -10.2467 | 1497.7 | 2739.0 | 2748 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 95.0 | 72.8270 | -10.2360 | 1501.5 | 2744.0 | 2754 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 90.0 | 72.8308 | -10.2296 | 1503.7 | 2750.0 | 2760 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 95.0 | 72.8309 | -10.2126 | 1509.1 | 2760.0 | 2770 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 40.0 | 72.8464 | -10.1998 | 1513.5 | 2768.0 | 2778 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 45.0 | 72.8529 | -10.1871 | 1516.2 | 2773.0 | 2787 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 90.0 | 72.8594 | -10.1744 | 1520.1 | 2780.0 | 2790 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 11 | 95.0 | 72.8660 | -10.1619 | 1525.5 | 2790.0 | 2800 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 0.0 | 72.8725 | -10.1505 | 1528.3 | 2795.0 | 2805 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 5.0 | 72.8790 | -10.1391 | 1529.9 | 2798.0 | 2809 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 0.0 | 72.8829 | -10.1323 | 1531.0 | 2800.0 | 2811 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 10.0 | 72.8855 | -10.1278 | 1532.1 | 2802.0 | 2813 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 15.0 | 72.8919 | -10.1164 | 1536.5 | 2810.0 | 2821 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 90.0 | 72.8984 | -10.1050 | 1539.8 | 2816.0 | 2827 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 95.0 | 72.9049 | -10.0937 | 1544.1 | 2824.0 | 2835 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 90.0 | 72.9113 | -10.0821 | 1549.1 | 2833.0 | 2844 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 95.0 | 72.9174 | -10.0703 | 1552.9 | 2840.0 | 2851 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 40.0 | 72.9239 | -10.0584 | 1558.3 | 2850.0 | 2862 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 45.0 | 72.9297 | -10.0466 | 1563.8 | 2860.0 | 2872 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 90.0 | 72.9360 | -10.0349 | 1570.1 | 2872.0 | 2884 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 95.0 | 72.9428 | -10.0233 | 1575.7 | 2882.0 | 2893 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 12 | 90.0 | 72.9482 | -10.0140 | 1594.4 | 2916.0 | 2929 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 5.0 | 72.9563 | -10.0001 | 1591.7 | 2911.0 | 2924 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 10.0 | 72.9631 | -9.9884 | 1597.2 | 2921.0 | 2934 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 15.0 | 72.9698 | -9.9762 | 1603.7 | 2933.0 | 2944 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 90.0 | 72.9763 | -9.9611 | 1607.6 | 2940.0 | 2953 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 95.0 | 72.9828 | -9.9461 | 1605.4 | 2936.0 | 2949 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 90.0 | 72.9893 | -9.9311 | 1605.4 | 2936.0 | 2949 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 95.0 | 72.9957 | -9.9160 | 1604.8 | 2935.0 | 2948 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 40.0 | 73.0022 | -9.9022 | 1604.8 | 2935.0 | 2948 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 45.0 | 73.0086 | -9.8891 | 1603.7 | 2933.0 | 2944 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 90.0 | 73.0151 | -9.8761 | 1603.2 | 2932.0 | 2943 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 13 | 95.0 | 73.0215 | -9.8631 | 1607.6 | 2940.0 | 2944 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 0.0 | 73.0280 | -9.8500 | 1604.8 | 2935.0 | 2948 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 5.0 | 73.0344 | -9.8370 | 1605.4 | 2936.0 | 2949 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 10.0 | 73.0408 | -9.8239 | 1610.3 | 2945.0 | 2959 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 12.5 | 73.0441 | -9.8174 | 1613.0 | 2950.0 | 2964 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 90.0 | 73.0534 | -9.7965 | 1626.7 | 2975.0 | 2989 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 95.0 | 73.0597 | -9.7824 | 1639.3 | 2998.0 | 3013 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 90.0 | 73.0659 | -9.7683 | 1634.4 | 2989.0 | 3004 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 95.0 | 73.0722 | -9.7543 | 1632.2 | 2985.0 | 2999 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 40.0 | 73.0792 | -9.7410 | 1632.2 | 2985.0 | 2999 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 45.0 | 73.0842 | -9.7277 | 1632.2 | 2985.0 | 2999 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 90.0 | 73.0932 | -9.7143 | 1630.0 | 2981.0 | 2995 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 14 | 95.0 | 73.1002 | -9.7010 | 1629.4 | 2980.0 | 2994 | 1 |
| 73-10-02 | 0 | 73 | 8 | 22 | 15 | 0.0 | 73.1072 | -9.6877 | 1629.4 | 2980.0 | 2994 | 2 |
| 73-10-02 | 0 | 73 | 8 | 22 | 15 | 5.0 | 73.1104 | -9.6756 | 1628.3 | 2978.0 | 2993 | 2 |
| 73-10-02 | 0 | 73 | 8 | 22 | 15 | 10.0 | 73.1137 | -9.6634 | 1627.2 | 2976.0 | 2991 | 2 |
| 73-10-02 | 0 | 73 | 8 | 22 | 15 | 15.0 | 73.1170 | -9.6513 | 1626.7 | 2975.0 | 2990 | 2 |

# SAMPLE MAGNETICS PRINTOUT

| SHIP AND CRUISE IDENTIFICATION | TIME ZONE | YEAR | MONTH | DAY | HOUR | MINUTE | LATITUDE | LONGITUDE | TOTAL MAGNETIC INTENSITY | RESIDUAL MAGNETIC INTENSITY |
|---|---|---|---|---|---|---|---|---|---|---|
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 10.0 | 72.9080 | -10.2681 | 52969 | 155 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 15.0 | 72.8143 | -10.2574 | 52964 | 149 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 20.0 | 72.8207 | -10.2467 | 52962 | 146 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 25.0 | 72.8270 | -10.2360 | 52962 | 145 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 30.0 | 72.8333 | -10.2253 | 52965 | 147 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 35.0 | 72.8399 | -10.2126 | 52964 | 144 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 40.0 | 72.8464 | -10.1998 | 52957 | 136 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 45.0 | 72.8529 | -10.1871 | 52965 | 143 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 50.0 | 72.8594 | -10.1744 | 52955 | 132 |
| 73-16-02 | 0 | 73 | 8 | 22 | 11 | 55.0 | 72.8660 | -10.1619 | 52948 | 124 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 0.0 | 72.8725 | -10.1505 | 52935 | 110 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 5.0 | 72.8790 | -10.1391 | 52934 | 108 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 10.0 | 72.8855 | -10.1278 | 52938 | 110 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 15.0 | 72.8919 | -10.1164 | 52947 | 118 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 20.0 | 72.8984 | -10.1050 | 52982 | 152 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 25.0 | 72.9049 | -10.0937 | 52995 | 164 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 30.0 | 72.9113 | -10.0821 | 53035 | 203 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 35.0 | 72.9174 | -10.0703 | 53075 | 242 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 40.0 | 72.9235 | -10.0584 | 53124 | 290 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 45.0 | 72.9297 | -10.0466 | 53162 | 327 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 50.0 | 72.9360 | -10.0349 | 53197 | 361 |
| 73-16-02 | 0 | 73 | 8 | 22 | 12 | 55.0 | 72.9428 | -10.0233 | 53224 | 386 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 0.0 | 72.9496 | -10.0117 | 53235 | 396 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 5.0 | 72.9563 | -10.0001 | 53230 | 390 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 10.0 | 72.9631 | -9.9884 | 53206 | 365 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 15.0 | 72.9698 | -9.9762 | 53165 | 323 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 20.0 | 72.9763 | -9.9611 | 53111 | 267 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 25.0 | 72.9828 | -9.9461 | 53043 | 198 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 30.0 | 72.9893 | -9.9311 | 52964 | 119 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 35.0 | 72.9957 | -9.9160 | 52931 | 84 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 40.0 | 73.0022 | -9.9022 | 52865 | 17 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 45.0 | 73.0086 | -9.8891 | 52820 | -29 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 50.0 | 73.0151 | -9.8761 | 52791 | -59 |
| 73-16-02 | 0 | 73 | 8 | 22 | 13 | 55.0 | 73.0215 | -9.8631 | 52769 | -82 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 0.0 | 73.0280 | -9.8500 | 52756 | -96 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 5.0 | 73.0344 | -9.8370 | 52784 | -89 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 10.0 | 73.0408 | -9.8239 | 52784 | -71 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 15.0 | 73.0472 | -9.8107 | 52809 | -47 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 20.0 | 73.0534 | -9.7965 | 52826 | -31 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 25.0 | 73.0597 | -9.7824 | 52828 | -30 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 30.0 | 73.0659 | -9.7683 | 52833 | -26 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 35.0 | 73.0722 | -9.7543 | 52835 | -25 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 40.0 | 73.0782 | -9.7410 | 52849 | -12 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 45.0 | 73.0862 | -9.7277 | 52862 | 0 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 50.0 | 73.0932 | -9.7143 | 52874 | 10 |
| 73-16-02 | 0 | 73 | 8 | 22 | 14 | 55.0 | 73.1002 | -9.7010 | 52893 | 28 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 0.0 | 73.1072 | -9.6877 | 52917 | 51 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 5.0 | 73.1104 | -9.6756 | 52934 | 69 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 10.0 | 73.1137 | -9.6634 | 52944 | 79 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 15.0 | 73.1170 | -9.6513 | 52954 | 88 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 20.0 | 73.1203 | -9.6392 | 52954 | 89 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 25.0 | 73.1235 | -9.6271 | 52957 | 89 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 30.0 | 73.1268 | -9.6150 | 52959 | 90 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 35.0 | 73.1299 | -9.6058 | 52961 | 92 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 40.0 | 73.1331 | -9.5957 | 52961 | 91 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 45.0 | 73.1362 | -9.5857 | 52989 | 115 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 50.0 | 73.1444 | -9.5659 | 52987 | 115 |
| 73-16-02 | 0 | 73 | 8 | 22 | 15 | 55.0 | 73.1558 | -9.5395 | 53005 | 131 |
| 73-16-02 | 0 | 73 | 8 | 22 | 16 | 0.0 | 73.1673 | -9.5132 | 53014 | 138 |

# SAMPLE PRINTOUT OF DATA PROCESSED

SHIP AND CRUISE IDENTIFICATION 751602

NAVIGATION DATA

NUMBER OF NAVIGATION CARDS READ = 60

NUMBER OF LOGICAL RECORDS WRITTEN ON TAPE = 60

BATHYMETRY DATA

DEPTH DATA GIVEN IN UNCORRECTED METERS

MATTHEWS ZONES PASSED THROUGH WERE 1 2 3

NUMBER OF BATHYMETRY CARDS READ = 72

NUMBER OF LOGICAL RECORDS WRITTEN = 357

MAGNETICS DATA

HEIGHT IN FEET ABOVE OR BELOW SEA LEVEL IS -20

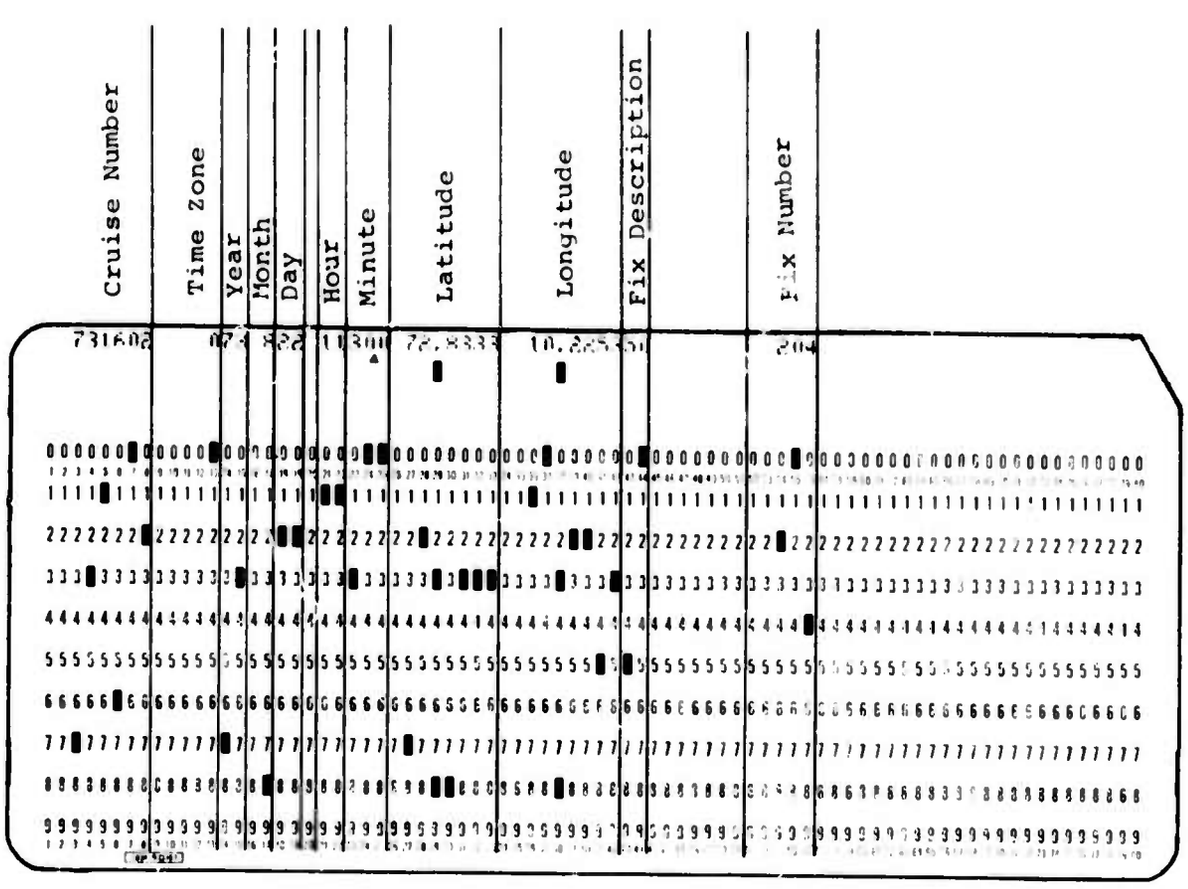
NUMBER OF MAGNETICS CARDS READ = 23

NUMBER OF LOGICAL RECORDS WRITTEN = 258

## Appendix C2

## SAMPLE OUTPUT CARDS

### NAVIGATION OUTPUT CARD

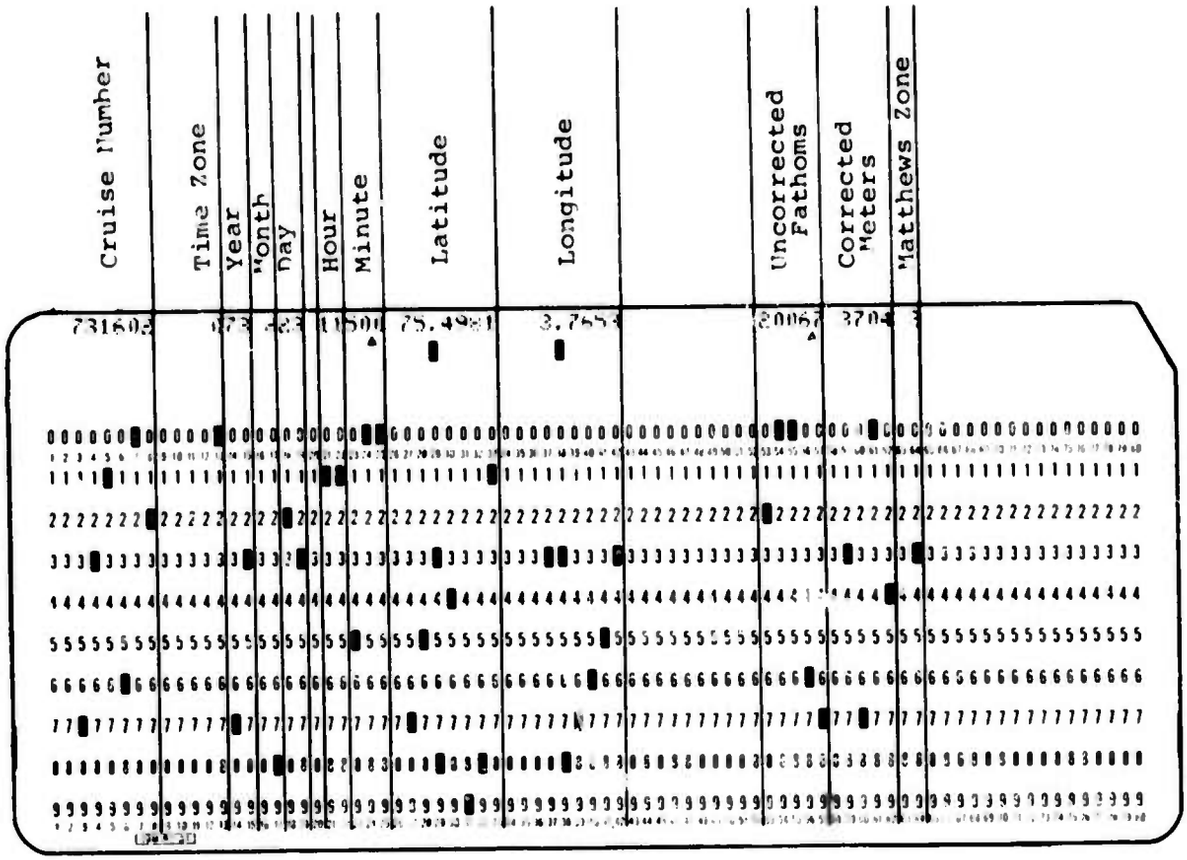



```
1 5 WRITE (62,110) (CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
   1),XLAT(I),XLONG(I),IFIX(I),NAVFIX(I),I=1,IWRITE)

110 FORMAT (A8,I5,I2,I2,I2,1XF2,F3,F8.4,F9.4,I2,7XI5,24X)
```

▲ Implies a decimal point

# BATHYMETRY OUTPUT CARD

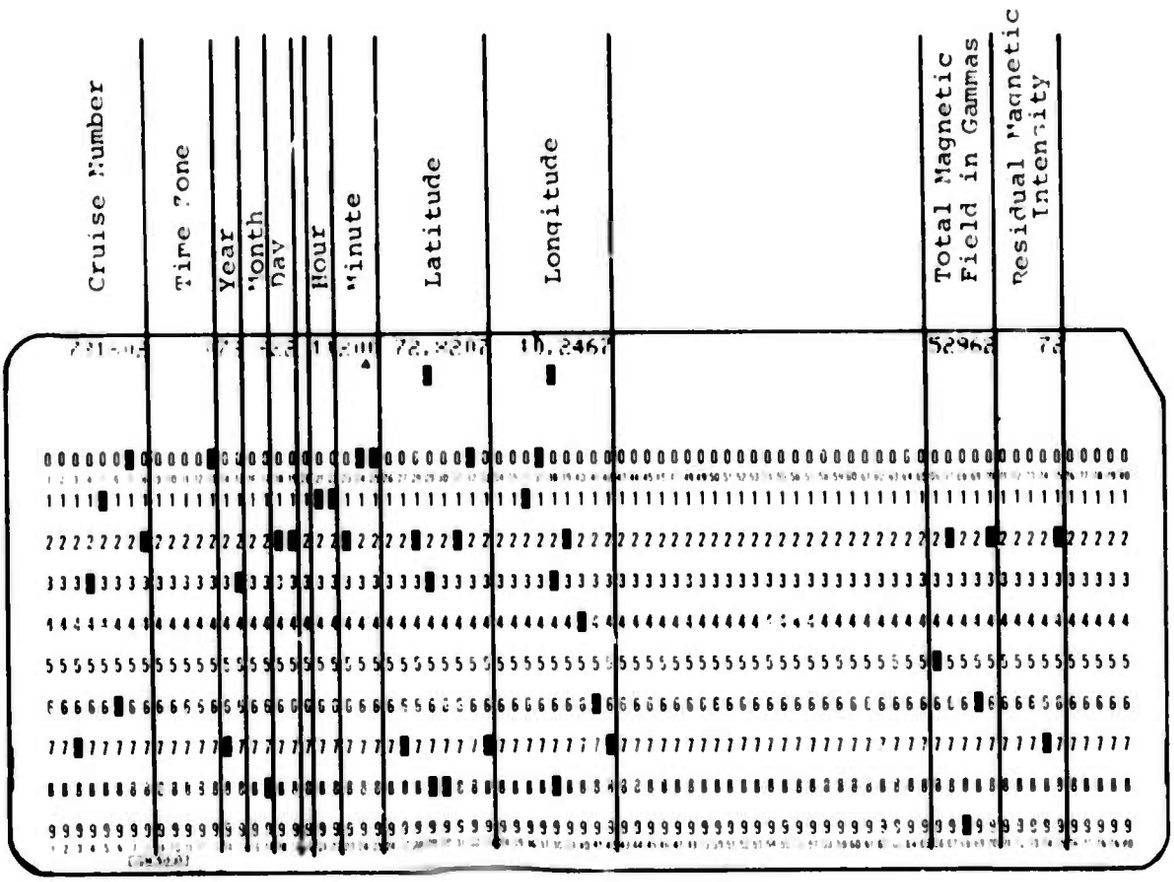



```
229 WRITE (62,224)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
   1),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),IFIX(I),I=1,IWRITE)

224 FORMAT (A8,I5,I2,I2,I2,1XF2,F3,F8.4,F9.4,10XI5,I5,I2,16X)
```

▲Implies a decimal point

# MAGNETICS OUTPUT CARD



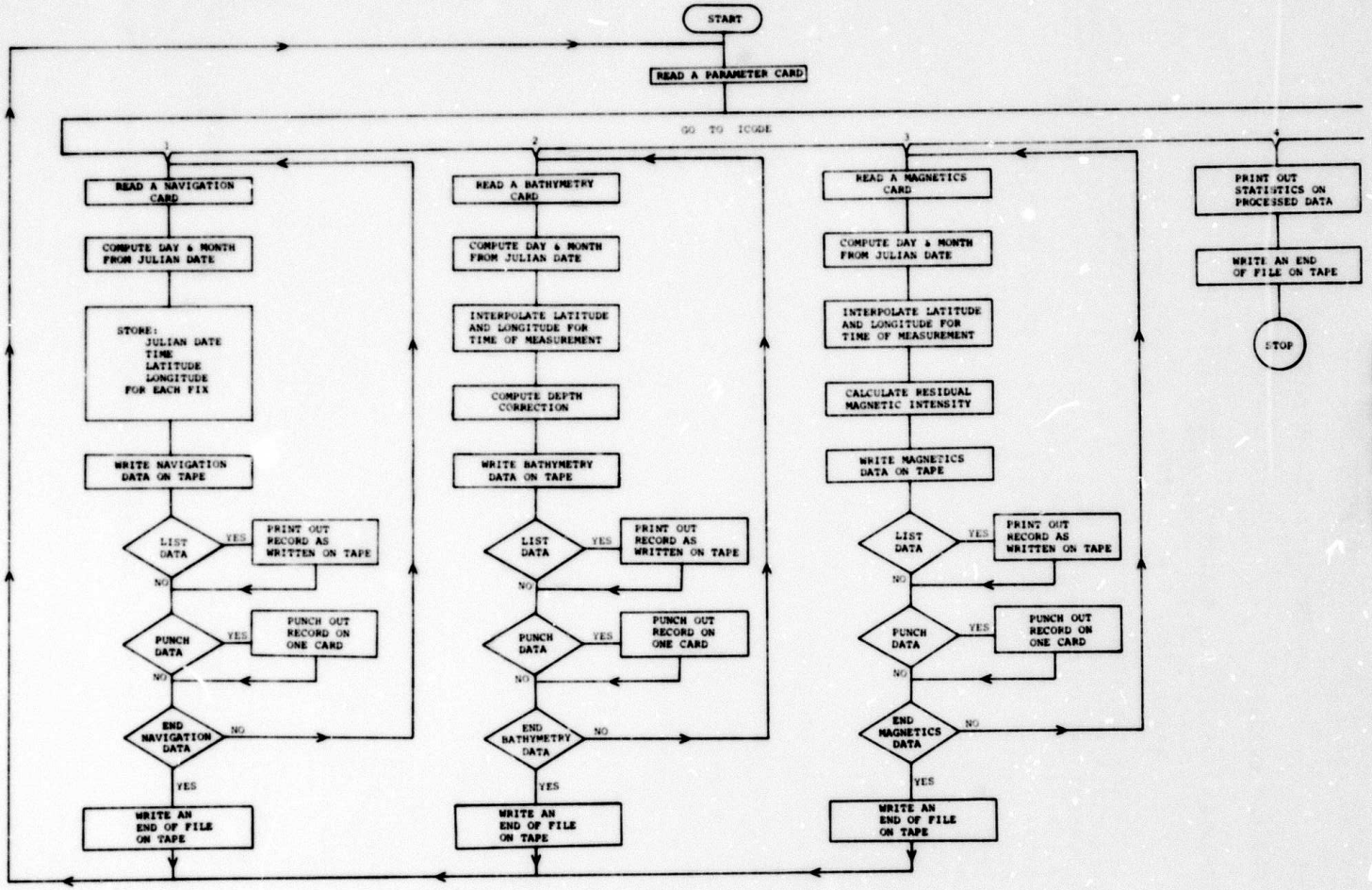

```
323 WRITE(62,318) (CURISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
   1),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),I=1,IWRITE)

318 FORMAT (A8,I5,I2,I2,I2,1XF2,F3,F8.4,F9.4,23X,I5,I5,5X)
```

▲ Implies a decimal point

## Appendix D1

## FLOW CHART


START
READ A PARAMETER CARD
GO TO ICODE
1
READ A NAVIGATION CARD
COMPUTE DAY & MONTH FROM JULIAN DATE
STORE: JULIAN DATE TIME LATITUDE LONGITUDE FOR EACH FIX
WRITE NAVIGATION DATA ON TAPE
LIST DATA
YES
PRINT OUT RECORD AS WRITTEN ON TAPE
NO
PUNCH DATA
YES
PUNCH OUT RECORD ON ONE CARD
NO
END NAVIGATION DATA
NO
YES
WRITE AN END OF FILE ON TAPE
2
READ A BATHYMETRY CARD
COMPUTE DAY & MONTH FROM JULIAN DATE
INTERPOLATE LATITUDE AND LONGITUDE FOR TIME OF MEASUREMENT
COMPUTE DEPTH CORRECTION
WRITE BATHYMETRY DATA ON TAPE
LIST DATA
YES
PRINT OUT RECORD AS WRITTEN ON TAPE
NO
PUNCH DATA
YES
PUNCH OUT RECORD ON ONE CARD
NO
END BATHYMETRY DATA
NO
YES
WRITE AN END OF FILE ON TAPE
3
READ A MAGNETICS CARD
COMPUTE DAY & MONTH FROM JULIAN DATE
INTERPOLATE LATITUDE AND LONGITUDE FOR TIME OF MEASUREMENT
CALCULATE RESIDUAL MAGNETIC INTENSITY
WRITE MAGNETICS DATA ON TAPE
LIST DATA
YES
PRINT OUT RECORD AS WRITTEN ON TAPE
NO
PUNCH DATA
YES
PUNCH OUT RECORD ON ONE CARD
NO
END MAGNETICS DATA
NO
YES
WRITE AN END OF FILE ON TAPE
4
PRINT OUT STATISTICS ON PROCESSED DATA
WRITE AN END OF FILE ON TAPE
STOP

## Appendix D2

## SOURCE LANGUAGE LISTING

```
      PROGRAM GEODATA
C
C  PROGRAMMER  MARILYN L. BLODGETT    CODE 7817MLB
C              NAVAL RESEARCH LABORATORY
C              WASHINGTON, D.C.   20375
C
      DIMENSION IYEAR(20),MONTH(20),IDAY(20),HR(20),XMIN(20),XLAT(20),
     1XLONG(20),IFIX(20),NAVFIX(20),IDATE(3000),STIME(3000),STLAT(3000),
     2STLONG(3000),KEEPMT(24),BHR(5),BMIN(5),IDP(5),ICRMET(20),ZAVFIX(20
     3),ITM(12),IMG(12),ZMIN(20),SIDP(20)
      DATA((ITM(I),I=1,12)=0,5,10,15,20,25,30,35,40,45,50,55)
      REAL IDEPTH
C     REWIND 06
      REWIND 10
C     IFLIGHT=1
      ITMZNE=0
      ICNTB=0
      ICNTN=0
      ICTMAG=0
C
C  READ A PARAMETER CARD
C
  100 READ(60,10)ICODE,MT,ALT,INPUT,IOUT,SHIPID
   10 FORMAT(I2,1X12,F5,3X12,3X12,2XA8)
      IF(ICODE)12,11,11
   11 WRITE(61,13)
   13 FORMAT(1H0,23HDECK SET UP INCORRECTLY)
      STOP
   12 IF(4*ICODE)11,14,14
   14 ICODE=-ICODE
      GO TO (100,200,300,400), ICODE
C
C  PROCESS THE NAVIGATION DATA CARDS
C
  100 CRUISE=SHIPID
      IOPT=IOUT
      NOWRIT=MT
      IF(NOWRIT  )166,165,166
  166 CALL SKIPFILE(10)
      READ(10,110)CRUISE
      IF(EOF,10)167,166
  167 CALL BACKFILE(10)
      GO TO 120
  165 IF(IOPT)121,120,121
  121 IF(IOPT-2)122,120,122
  122 WRITE(61,501)
  501 FORMAT(1H1,123HSHIP AND CRUISE     TIME     YEAR     MONTH     DAY
     1     HOUR     MINUTE     LATITUDE     LONGITUDE          FIX
     2   FIX)
      WRITE(61,502)
  502 FORMAT(1H ,24HIDENTIFICATION      ZONE,79X,22HDESCRIPTION      NUMB
     1ER)
  120 IENDFL=0
      IWRITE=0
      NLREC=0
      NPREC=0
```

```
      ISTORE=1
C
C  READ A NAVIGATION CARD
C
  100 READ(60,101)ISN,IY,JUDY,RNHR,RNMIN,IFN,XLAD,XLAM,XL0D,XL0M,IFIXTY
C101  FORMAT(I2,4X12,1XI3,1XF2,F2,2XI3,1XF2,F6.2,F4,F6,2,1XI2,36X)
  101 FORMAT(I2,4X12,1XI3,1XF2,F2,I5,F3,F6.2,F4,F6.2,1XI2)
      IF(5-ISN)11,102,104
  102 IF(NOWRIT)160,170,160
  170 IENDFL=1
      IF(IWRITE)150,150,103
  103 NLREC=NLREC+IWRITE
      NPREC=NPREC+1
      IBEG=IWRITE+1
      DO 117 K=IBEG,20
      IYEAR(K)=0
      MONTH(K)=0
      IDAY(K)=0
      HR(K)=0
      XMIN(K)=0.0
      ZMIN(K)=0
      XLAT(K)=0.0
      XLONG(K)=0.0
      IFIX(K)=0
  117 NAVFIX(K)=0
      IWRITE=20
      GO TO 140
  104 IYR=IY
      ICNTN=ICNTN+1
      IF(3001-ICNTN)105,105,106
  105 WRITE(61,107)
  107 FORMAT(1H0,36HMORE THAN 3000 NAVIGATION DATA CARDS)
      STOP
C
C  COMPUTE DAY AND MONTH FROM JULIAN DATE
C
  106 CALL JULIAN(IYR,JUDY,ID,IM,LPYR)
C     XL0D=-XL0D
      XL0D=-XL0D
      MINUS=4000000000000000B
      XLAM=ABSF(XLAM)
      XL0M=ABSF(XL0M)
      KOY=XLAD.AND.MINUS
      IF(KOY.EQ.MINUS)27,28
   27 COMLAT=XLAD-XLAM/60.0
      GO TO 29
   28 COMLAT=XLAD + XLAM/60.0
   29 KEY=XL0D.AND.MINUS
      IF(KEY.EQ.MINUS)30,31
   30 COML0N=XL0D-XL0M/60.0
      GO TO 164
   31 COML0N=XL0D+XL0M/60.0
  164 TIME=RNHR+RNMIN/60.0
C
C  STORE JULIAN DAY, TIME, LATITUDE AND LONGITUDE FOR EACH FIX
C
```

```
      IDATE(ISTORE)=JUDY
      STIME(ISTORE)=TIME
      STLAT(ISTORE)=COMLAT
      STLONG(ISTORE)=COMLON
      ISTORE=ISTORE+1
      IF(NOWRIT)108,171,108
C
C  STORE INFORMATION FOR WRITING ON TAPE
C
 171  IWRITE=IWRITE+1
      IYEAR(IWRITE)=IYR
      MONTH(IWRITE)=IM
      IDAY(IWRITE)=ID
      HR(IWRITE)=RNHR
      XMIN(IWRITE)=RNMIN*10.0
      ZMIN(IWRITE)=XMIN(IWRITE)/10.0
      XLAT(IWRITE)=COMLAT
      XLONG(IWRITE)=COMLON
      IFIX(IWRITE)=IFIXTY
      NAVFIX(IWRITE)=IFN
      IF(20-IWRITE)109,109,108
 109  NLREC=NLREC+20
      NPREC=NPREC+1
C
C  WRITE LOGICAL RECORDS ON TAPE
C
 140  WRITE(10,110)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
     1),XLAT(I),XLONG(I),IFIX(I),NAVFIX(I),I=1,IWRITE)
 110  FORMAT(A8,I5,I2,I2,I2,1XF2,F3,F8.4,F9.4,  I2,7XI5,24X)
      IF(IOPT)111,112,111
 111  IF(IOPT-2)113,115,114
 116  FORMAT(1H ,2XA8,7XI5,7XI2,7XI2,7XI2,7XF2.7XF4.1,6XF8.4,5XF9.4,9XI2
     1,10XI5)
 113  IF(NPREC-1)601,600,601
 600  WRITE(61,116)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),ZMIN(I
     1),XLAT(I),XLONG(I),IFIX(I),NAVFIX(I),I=1,IWRITE)
      GO TO 112
 601  IF(MOD(NPREC,3),NE.1) GO TO 600
      WRITE(61,501)
      WRITE(61,502)
      GO TO 600
 114  IF(NPREC-1)604,603,604
 603  WRITE(61,116)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),ZMIN(I
     1),XLAT(I),XLONG(I),IFIX(I),NAVFIX(I),I=1,IWRITE)
      GO TO 115
 604  IF(MOD(NPREC,3),NE.1) GO TO 603
      WRITE(61,501)
      WRITE(61,502)
      GO TO 603
 115  WRITE(62,110)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
     1),XLAT(I),XLONG(I),IFIX(I),NAVFIX(I),I=1,IWRITE)
 112  IWRITE=0
      IF(IENDFL)150,108,150
 150  ENDFILE 10
      GO TO 160
```

```
C  PRECESS THE BATHYMETRY DATA CARDS
C
 200   DO 201 L=1,24
 201   KEEPMT(L)=0
       KKMT=1
       KEEPMT(1)=MT
       IENDFL=0
       IWRITE=0
       IFIELD=0
       IBLREC=0
       IBPREC=0
       IOPT=IOUT
       KNPUT=INPLT
       IF(IOPT)241,240,241
 241   IF(IOPT-2)242,240,242
 242   WRITE(61,504)
 504   FORMAT(1H1,133HSHIP AND CRUISE   TIME   YEAR   MONTH   DAY   HOUR
      1  MINUTE   LATITUDE   LONGITUDE   UNCORRECTED   UNCORRECTED   CORR
      2ECTED   MATTHEWS)
       WRITE(61,505)
 505   FORMAT(1H ,22HIDENTIFICATION     ZONE,65X,44HFATHOMS          METERS
      1      METERS       ZONE)
 240   DO 202 J=1,ICNTN
       IF(IFIELD)203,205,203
C
C  READ A BATHYMETRY CARD
C
 205   READ(60,204)ISN,JUDY,(BHR(I),BMIN(I),IDP(I),I=1,5)
C204   FORMAT(I2,I1,1X,5(F2,F4.1,1X,I4))
 204   FORMAT(I2,1X,I3,5(1X,F2,F3.1,1X,I4))
       IF(ISN)206,207,207
 206   IF(ISN+6)209,208,209
 209   IF(ISN+7)11,234,11
 234   IENDFL=1
       IF(IWRITE)232,232,235
 235   IBLREC=IBLREC+IWRITE
       IBPREC=IBPREC+1
       IBEG=IWRITE+1
       DO 236 K=IBEG,20
       IYEAR(K)=0
       MONTH(K)=0
       IDAY(K)=0
       HR(K)=0
       XMIN(K)=0
       XLAT(K)=0
       XLONG(K)=0
       NAVFIX(K)=0
       ICRMET(K)=0
       SIDP(K)=0
 236   IFIX(K)=0
       IWRITE=20
       GO TO 223
 208   MT=JUDY
C208   MT=BHR(1)
       DO 210 L=1,24
       IF(KEEPMT(L))211,211,212
```

```
 212  IF(KEEPMT(L)-MT)210,205,210
 210  CONTINUE
 211  KEEPMT(L)=MT
      KKMT=L
      GO TO 205
 207  ICNTB=ICNTB+1
C     JUDY=ISN*10 + JUDY
      IFIELD=1
C
C  COMPUTE DAY AND MONTH FROM JULIAN DATE
C
      CALL JULIAN(IYR,JUDY,ID,IM,LPYR)
C
C  INTERPOLATE LATITUDE AND LONGITUDE AT THE TIME OF MEASUREMENT
C
 203  TIME=BHR(IFIELD)+BMIN(IFIELD)/60.0
      IF(BHR(IFIELD))273,270,273
 270  IF(BMIN(IFIELD))273,271,273
 271  IF(IDP(IFIELD))273,209,273
 273  IF(IDATE(L)-JUDY)204,213,217
 213  IF(TIME.LE.STIME(J))215,202
 215  IF(TIME-STIME(J))217,216,217
 216  XD=STLONG(J)
      YD=STLAT(J)
      GO TO 237
 217  TNB=STIME(J)
      TNA=STIME(J-1)
      TDX=TIME
      XNA=STLONG(J-1)
      YNA=STLAT(J-1)
      XNB=STLONG(J)
      YNB=STLAT(J)
      CALL PROPER(TNA,TNB,TDX,XNA,YNA,XNB,YNB,XD,YD)
C
C  COMPUTE DEPTH CORRECTION ACCORDING TO THE MATTHEWS ZONE NUMBER
C
 237  IF(INPUT-1)219,219,218
 218  IDEPTH=IDP(IFIELD)/1.6288
      GO TO 220
 219  IDEPTH=IDP(IFIELD)
 220  CALL MTCOR(IDEPTH,MT,KORFAT,KORMET,METUNC,MTDC)
      IWRITE=IWRITE+1
C
C  STORE INFORMATION FOR WRITING ON TAPE
C
      IYEAR(IWRITE)=IYR
      MONTH(IWRITE)=IM
      IDAY(IWRITE)=ID
      HR(IWRITE)=BHR(IFIELD)
      XMIN(IWRITE)=BMIN(IFIELD)*10.0
      XLAT(IWRITE)=YD
      XLONG(IWRITE)=XD
      NAVFIX(IWRITE)=IDEPTH*10.
      ICRMET(IWRITE)=KORMET
      IFIX(IWRITE)=MT
      IF(INPUT-1)274,274,275
```

```
 275  SIDP(IWRITE)=IDP(IFIELD)
      GO TO 276
 274  SIDP(IWRITE)=IDP(IFIELD)+1.8288
 276  IF(20-IWRITE)222,222,221
 222  IBLREC=IBLREC+20
      IBPREC=IBPREC+1
C
C  WRITE LOGICAL RECORDS ON TAPE
C
 223  WRITE(10,224)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
     1),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),IFIX(I),I=1,IWRITE)
 224  FORMAT(A8,I5,I2,I2,I2,1XF2,F3.?8,4,F9.4,4,I0XI5,I5,I2,I6X)
      IF(IOPT)225,226,225
 607  WRITE(61,228)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),ZMIN(I
     1),XLAT(I),XLONG(I),ZAVFIX(I),SIDP(I),ICRMET(I),IFIX(I),I=1,IWRITE)
 228  FORMAT(1H ,2XA8,5XI5,5XI2,5XI2,5XI2,5XF2.5,5XF4.1,4XF8.4,3XF9.4,5XF6
     1.1,8XF6.1,7XI5,9XI2)
      GO TO 226
 225  DO 230 I=1,20
      ZMIN(I)=XMIN(I)/10.0
 230  ZAVFIX(I)=NAVFIX(I)/10.
      IF(IOPT-2)227,229,231
 227  IF(IBPREC-1)605,607,605
 605  IF(MOD(IBPREC,3).NE.1) GO TO 607
      WRITE(61,504)
      WRITE(61,505)
      GO TO 607
 231  IF(IBPREC-1)609,608,609
 609  IF(MOD(IBPREC,3).NE.1) GO TO 608
      WRITE(61,504)
      WRITE(61,505)
      GO TO 608
 608  WRITE(61,228)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),ZMIN(I
     1),XLAT(I),XLONG(I),ZAVFIX(I),SIDP(I),ICRMET(I),IFIX(I),I=1,IWRITE)
 229  WRITE(62,224)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I),HR(I),XMIN(I
     1),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),IFIX(I),I=1,IWRITE)
 226  IWRITE=0
      IF(IENDFL)232,221,232
 232  ENDFILE 10
      GO TO 160
 221  IFIELD=IFIELD+1
      IF(IFIELD-6)203,205,205
 202  CONTINUE
      WRITE(61,233)
 233  FORMAT(1H0,44HUNABLE TO INTERPOLATE LATITUDE AND LONGITUDE)
      STOP
C
C  PROCESS THE MAGNETICS DATA CARDS
C
 300  M=1
      IOPT=IOUT
      IENDFL=0
      IWRITE=0
      MLREC=0
      MPREC=0
      IFIELD=0
```

```
      IF(IOPT)341,340,341
  341 IF(IOPT-2)342,340,342
  342 WRITE(61,507)
  507 FORMAT(1H1,129HSHIP AND CRUISE    TIME    YEAR    MONTH    DAY
     1HOUR    MINUTE    LATITUDE    LONGITUDE    TOTAL MAGNETIC    RESID
     2UAL MAGNETIC)
      WRITE(61,508)
  508 FORMAT(1H ,23HIDENTIFICATION      ZONE,73X,29HINTENSITY              I
     1NTENSITY)
  340 DO 301 J=1,ICNTN
      IF(IFIELD)303,302,303
C
C  READ A MAGNETICS CARD
C
C302  READ(06,304)JUDY,(RMHR(I),RMMIN(I),RMSEC(I),IALT(I),IMG(I),
C     1I=1,12)
C304  FORMAT(I3,6(3F2,I4,I5)/6(3F2,I4,I5))
C     IF(EOF,06)305,306
C305  IFLIGHT=IFLIGHT+1
C     IF(IFLIGHT-13)302,302,325
  302 READ(60,304)ISN,JUDY,RMHR,(IMG(I),I=1,12)
  304 FORMAT(I2,I3,1XF2,12(1X,I5))
      IF(ISN)305,306,306
  305 IF(ISN+8)11,325,11
  325 IENDFL=1
      IF(IWRITE)324,324,326
  326 MLREC=MLREC+IWRITE
      MPREC=MPREC+1
      IBEG=IWRITE+1
      DO 327 K=IBEG,20
      IYEAR(K)=0
      MONTH(K)=0
      IDAY(K)=0
      XLAT(K)=0
      XLONG(K)=0
      HR(K)=0
      XMIN(K)=0
      ZMIN(K)=0
      NAVFIX(K)=0
  327 ICRMET(K)=0
      IWRITE=20
      GO TO 317
  306 ICTMAG=ICTMAG+1
      IFIELD=1
C
C  COMPUTE DAY AND MONTH FROM JULIAN DATE
C
      CALL JULIAN(IYR,JUDY,ID,IM,LPYR)
C
C  INTERPOLATE LATITUDE AND LONGITUDE AT THE TIME OF MEASUREMENT
C
  303 TM=ITM(IFIELD)
      TIME=RMHR+TM/60.0
C303  TM=RMMIN(IFIELD) + RMSEC(IFIELD)/60.0
C     TIME=RMHR(IFIELD) + TM/6010
C     IF(IFLIGHT-2)700,700,701
```

```
0700  ALT=1200.
      GO TO 702
0701  ALT=IALT(IFIELD)*100
      IF(IMG(IFIELD))350,315,350
 350  IF(IDATE(J)-JUDY)301,307,308
 307  IF(TIME.LE.STIME(J))309,301
 309  IF(TIME-STIME(J))308,310,308
 310  XD=STLONG(J)
      YD=STLAT(J)
      GO TO 330
 308  TNB=STIME(J)
      TNA=STIME(J-1)
      TDX=TIME
      XNA=STLONG(J-1)
      YNA=STLAT(J-1)
      XNB=STLONG(J)
      YNB=STLAT(J)
      CALL PROPER(TNA,TNB,TDX,XNA,YNA,XNB,YNB,XD,YD)
C
C   CALCULATE RESIDUAL MAGNETIC INTENSITY
C
 330  CALL SPHERE(XD,YD,GLON,GLAT)
      ZYR=IYR
      IF(LPYR-2)311,329,311
 329  LEAP=366
      GO TO 312
 311  LEAP=365
 312  DATE=1900. + ZYR + (FLOATF(JUDY)/FLOATF(LEAP))
      ITYPE=1
      IF(ALT)314,313,314
 313  ALT=1.0
 314  BLT=.3048 * ALT/1000.
      CALL IGRF(DATE,ITYPE,BLT,GLAT,GLON,XV,YV,ZV,TV)
      ITV=TV
      NDP=IMG(IFIELD)-ITV
      STALT=ALT
C
C  STORE INFORMATION FOR WRITING ON TAPE
C
      IWRITE=IWRITE+1
      IYEAR(IWRITE)=IYR
      MONTH(IWRITE)=IM
      IDAY(IWRITE)=ID
      XLAT(IWRITE)=YD
      XLONG(IWRITE)=XD
      HR(IWRITE)=RMHR
      XMIN(IWRITE)=ITM(IFIELD)*10
      ZMIN(IWRITE)=ITM(IFIELD)
      NAVFIX(IWRITE)=IMG(IFIELD)
      ICRMET(IWRITE)=NDP
      IF(20-IWRITE)316,316,315
 316  MLREC=MLREC+20
      MPREC=MPREC+1
C
C  WRITE LOGICAL RECORDS ON TAPE
C
```

```
  317  WRITE(10,318)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I), HR(I),XMIN(
      1I),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),I=1,IWRITE)
  318  FORMAT(A8,I5,I2,I2,I2,1XF2,F3,F8.4,F9.4,23X,I5,I5,5X)
       IF(IOPT)319,320,319
  319  IF(IOPT-2)321,323,322
  321  IF(MPREC-1)611,610,611
  611  IF(MOD(MPREC,3).NE.1) GO TO 610
       WRITE(61,507)
       WRITE(61,508)
       GO TO 610
  322  IF(MPREC-1) 613,612,613
  613  IF(MOD(MPREC,3).NE.1) GO TO 612
       WRITE(61,507)
       WRITE(61,508)
       GO TO 612
  610  WRITE(61,328)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I), HR(I),ZMIN(
      1I),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),I=1,IWRITE)
       GO TO 320
  612  WRITE(61,328)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I), HR(I),ZMIN(
      1I),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),I=1,IWRITE)
  328  FORMAT(1H ,2XA8,6X15,3(6X12),6XF2,6XF4.1,5XF8.4,4XF9.4,8X15,15X15)
  323  WRITE(62,318)(CRUISE,ITMZNE,IYEAR(I),MONTH(I),IDAY(I), HR(I),XMIN(
      1I),XLAT(I),XLONG(I),NAVFIX(I),ICRMET(I),I=1,IWRITE)
  320  IWRITE=0
       IF(IENDFL)324,315,324
  324  ENDFILE 10
       GO TO 160
  315  IFIELD=IFIELD + 1
C315  IFIELD=IFIELD+1
       IF(IFIELD-13)303,306,303
  301  CONTINUE
       WRITE(61,233)
       STOP
C
C  WRITE OUT ACCUMULATED DATA
C
  400  WRITE(61,510)
  510  FORMAT(1HB)
       WRITE(61,401)CRUISE
  401  FORMAT('1H1,35HSHIP AND CRUISE IDENTIFICATION      ,A8)
       IF(NOWRIT)173,172,173
  172  WRITE(61,403)
  403  FORMAT(1H0,15HNAVIGATION DATA)
       WRITE(61,404)ICNTN
  404  FORMAT('1H0,34HNUMBER OF NAVIGATION CARDS READ = ',I4)
       WRITE(61,405)NLREC
  405  FORMAT(1H0,44HNUMBER OF LOGICAL RECORDS WRITTEN ON TAPE = ',I4///)
  173  IF(NOWRIT-1)174,174,175
  174  WRITE(61,407)
  407  FORMAT(1H0,15HBATHYMETRY DATA)
       IF(KNPUT-1)408,408,409
  408  WRITE(61,410)
  410  FORMAT(1H0,39HDEPTH DATA GIVEN IN UNCORRECTED FATHOMS)
       GO TO 411
  409  WRITE(61,412)
  412  FORMAT(1H0,38HDEPTH DATA GIVEN IN UNCORRECTED METERS)
```

```
411   WRITE(61,413)(KEEPMT(K),K=1,KKMT)
413   FORMAT(1H0,35HMATTHEWS ZONES PASSED THROUGH WERE ,24I4)
      WRITE(61,414)ICNTB
414   FORMAT(1H0,34HNUMBER OF BATHYMETRY CARDS READ = ,I5)
      WRITE(61,415)IBLREC
415   FORMAT(1H0,36HNUMBER OF LOGICAL RECORDS WRITTEN = ,I6///)
175   IF(NOWRIT-1)176,177,176
176   WRITE(61,417)
417   FORMAT(1H0,14HMAGNETICS DATA)
      WRITE(61,418)STALT
418   FORMAT(1H0,43HHEIGHT IN FEET ABOVE OR BELOW SEA LEVEL IS ,F5)
      WRITE(61,419)ICTMAG
419   FORMAT(1H0,33HNUMBER OF MAGNETICS CARDS READ = ,I12)
      WRITE(61,420)MLREC
420   FORMAT(1H0,36HNUMBER OF LOGICAL RECORDS WRITTEN = ,I12)
177   ENDFILE 10
      REWIND 10
      STOP
      END
```

```
5,4DS   GE@DATA

                                          IDENT     GE@DATA
        PROGRAM LENGTH                  33405
        ENTRY POINTS    GE@DATA         30767
        EXTERNAL SYMB@LS
                        C8@ENTRY
                        THEND.
                        C8@ST@PS
                        C1C10100
                        C8@DICT.
                        SKIPFILE
                        BACKFILE
                        JULIAN
                        PR@POR
                        MTC@R
                        SPHERE
                        IGRF
                        XM@LF
                        C8@IFE@F
                        EFT.
                        REW.
                        TSH.
                        STH.
                        CNSINGL.
          00625 SYMB@LS
```

```
      SUBROUTINE JULIAN (IY,JUDY,ID,IM,LPYR)                                F   1
C     CNVERTS JULIAN DATE INTO DAY, MONTH, YEAR FOR ANNOTATION IN OCEANO    F   2
C     IY = YEAR, JUDY = JULIAN DAY, ID = CALENDER DAY, IM = CALENDER MON    F   3
C     CMPLIMENTS OF BOB FEDEN - CODE 8174 - 17 NOV 1971                     F   4
C     MODIFIED BY LEON LA LUMIERE - CODE 8178 - 17 NOV 1971                 F   5
C                                                                           F   6
      DIMENSION JJ(13), AA(12)                                              F   7
      TYPE INTEGER AA                                                       F   8
      DATA ((JJ(I), I = 1, 13) = 0, 31, 59, 90, 120, 151, 181, 212, 243,    F   9
     1273, 304, 334, 365)                                                   F  10
      DATA ((AA(I), I = 1, 12) = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)     F  11
      LL=IY                                                                 F  12
      MM=JUDY                                                               F  13
      IF (LL.LT.0) GO TO 10                                                 F  14
      IF (LL.EQ.0) GO TO 1                                                  F  15
      IF (MOD(LL,4).EQ.0) GO TO 4                                           F  16
    1 IF (MM.LE.0.OR.MM.GT.365) GO TO 4                                     F  17
    2 DO 3 K=2,13                                                           F  18
      IF (MM.LE.JJ(K)) GO TO 6                                              F  19
    3 CONTINUE                                                              F  20
    4 LPYR=2                                                                F  21
      IF (MM.LE.0.OR.MM.GT.366) GO TO 10                                    F  22
      IF (MM.LE.59) GO TO 2                                                 F  23
      IF (MM.EQ.60) GO TO 5                                                 F  24
      MM=MM-1                                                               F  25
      GO TO 2                                                               F  26
    5 II=29                                                                 F  27
      K=3                                                                   F  28
      GO TO 7                                                               F  29
    6 II=MM-JJ(K-1)                                                         F  30
      IF (LL.EQ.0) GO TO 8                                                  F  31
      IF (MOD(LL,4).NE.0) GO TO 8                                           F  32
      IF (MOD(LL,4).EQ.0.AND.MM.LE.59) GO TO 8                              F  33
      MM=MM+1                                                               F  34
    7 IF (LL.GE.10) GO TO 8                                                 F  35
    8 ID=II                                                                 F  36
      IM=AA(K-1)                                                            F  37
    9 RETURN                                                                F  38
   10 PRINT 11, LL,MM                                                       F  39
      GO TO 9                                                               F  40
C                                                                           F  41
   11 FORMAT (1X,'YEAR = ',I2,1X,'JULIAN DAY = ',I3,1X,'ARE BAD DATES')     F  42
      END                                                                   F  43.
```

```
5,4DS    JULIAN

                                        IDENT     JULIAN
PROGRAM LENGTH                  00301
ENTRY POINTS     JULIAN         00053
EXTERNAL SYMBOLS
                 THEND.
                 CBCDICT.
                 XM@DF
                 STH.
                 ONSINGL.
  00116 SYMBOLS
```

```
      SUBROUTINE PROPOR (TNA,TNB,TDX,XNA,YNA,XNB,YNB,XD,YD)                 M    1
C     COMPUTES THE X-Y COORDINATES FOR PLOTTING BATHYMETRY                  M    2
C     PROGRAMMER - LEON LA LUMIERE - CODE 8174 - 15 DEC 1971                M    3
C                                                                           M    4
      PERIOD=TNB-TNA                                                        M    5
      DELT=TDX-TNA                                                          M    6
      RATIO=DELT/PERIOD                                                     M    7
      DELX=XNB-XNA                                                          M    8
      DELY=YNB-YNA                                                          M    9
      XD=DELX*RATIO+XNA                                                     M   10
      YD=DELY*RATIO+YNA                                                     M   11
      RETURN                                                                M   12
      END                                                                   M   13.
```

```
9,4DS     FR@P@R

          PR@GRAM LENGTH                        IDENT     PR@P@R
          ENTRY P0INTS    PR@P0R      00140
          EXTERNAL SYMB0LS            00003
                          08@DICT.
             00C54 SYMB0LS
```

FTN5.4A

```
      SUBROUTINE SPHERE(DLON,DLAT,GLON,GLAT)
      IF(DLON)10,20,20
10    GLON=DLON
      GO TO 30
20    GLON=360. - DLON
30    GLAT=90. *DLAT
      RETURN
      END
```

```
5,4DS    SPHERE

                                        IDENT     SPHERE
      PROGRAM LENGTH                 00102
      ENTRY POINTS    SPHERE         00003
      EXTERNAL SYMBOLS
                      C8CDICT,
         00033 SYMBOLS
```

```
      SUBROUTINE MTCOR (IDEP,MT,KCDF,KCDM,METUNC,MTDC)                          J    1
C                                                                               J    2
C     JAN 10, 1972                                                              J    3
C                                                                               J    4
C     MODIFIED FOR CDC 3800 BY LEON LA LUMIERE - CODE 8174 - 20 MAR 1972        J    5
C                                                                               J    6
C     SUBROUTINE MTCOR(ARG); MATTHEWS TABLE CORRECTION                          J    7
C          VERSION WHERE COEFFICIENTS ENTERED AT RUN TIME                       J    8
C     CALCULATES CORRECTED DEPTH IN METERS WHEN GIVEN                           J    9
C          MATTHEWS TABLE COEFFICIENTS AND UNCORRECTED                          J   10
C          DEPTH IN FATHOMS;                                                    J   11
C     COPIED FROM WHOI PROGRAM FOR IBM 1130                                     J   12
C                                                                               J   13
C     INPUT,                                                                    J   14
C          IDEP = UNCORRECTED DEPTH IN FATHOMS                                  J   15
C          MT = MATTHEWS TABLE COEFFICIENT(1 - 52)                              J   16
C                                                                               J   17
C     OUTPUT,                                                                   J   18
C          KCDF = CORRECTED DEPTH IN FATHOMS                                    J   19
C          KCDM = CORRECTED DEPTH IN METERS                                     J   20
C          MTDC = MATHEWS TABLE DEPTH CORRECTION (METERS)                       J   21
C                                                                               J   22
C     INTERNAL                                                                  J   23
C          NUDF  WATER DEPTH UNCORRECTED FATHOMS                                J   24
C          WUDF  WATER DEPTH UNCORRECTED FATHOMS                                J   25
C          WUDM  WATER DEPTH UNCORRECTED METERS                                 J   26
C          WCOR  CORRECTION IN METERS                                           J   27
C                                                                               J   28
C     SETTING MATTHEWS TABLE COEFFICIENTS SUPPLIED BY C, GANTAR                 J   29
      DIMENSION MTN(52),AMT(52),BMT(52),CMT(52),DMT(52),EMT(52),FMT(52)         J   30
C                                                                               J   31
      REAL IDEP
      DATA (MTN=1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20.21,22        J   32
     1.23,24,25,26.27,28,29,30.31,32,33,34,35,36,37.38,39,40,41,42.43,44        J   33
     2.45,46,47,48.49,50,51,52)                                                 J   34
      DATA (AMT=-.05,.21,.19,.25,.35,.43,.12,-.21,.76,-,.19,-.07,1.29,.34       J   35
     1.-,04,,12,.39,1.18,1.25,-,11,.44,-,.31,.43,-.29,-.06,-,110,-.08,-.2      J   36
     23,,06,1.14,-.38,.2,-.56,.34,.58,1.15,.58,.01,.59,2.49,.97,3.93,1.9       J   37
     36,-.15,.09,.06,.42,-.05,.03,-,41,-,19,-,01,.07)                           J   38
      DATA (BMT=-.01683,-,00247,.006885,,000632,.015719,,004269,.013881,        J   39
     1.025565,,030789,.023035,.031673,.03649i,.031972,,049788,,032253,.0        J   40
     240042,,037533,.043541,.046531,.034097,,019659,,025093,.012063,.005        J   41
     3833,-,000139,-.006374,-,00994,-.012026,-,019317,-,011231,.034103,.        J   42
     4037121,.037874,.03524,.031429,.037872,.043038,.0398,.025775,.03583        J   43
     58,,021001,.0186,.021906,.013118,.001109,.044699,.02651,.028006,.03        J   44
     65524,,03841,.049807,.000832)                                              J   45
      DATA (CMT=.130695,-,028055,-.033416,,030785,-,169795,,049419,-.059        J   46
     1931,-,156579,-.141286,.00879,-,101806,-.121871,-,040565,-.233986,.        J   47
     2011268,-,363995,-.227638,-.239633,-.383832,-.24561,-,044804,-.2165        J   48
     309,-,014753,-.009209,,021746,.082109,.101101,.11845,.193882,.06327        J   49
     48,-.255508,-.174712,-,196492,-.149662,-.141422,-.17812,-.210477,-.        J   50
     5103453,-,092957,-.142494,-.04741,-.02271,-.117873,-,039335,.023648        J   51
     6,-,271705,-.041812,,048156,-.059269,-.097981,.001276,.161859)             J   52
      DATA (DMT=-.040587,,017161,-.00471,.012525,.115271,-,015992,.04609        J   53
     14,,083656,.05727,-.01941,,036137,.039775,.004688,,083487,-.030352,        J   54
     2.207727,,102774,.099135,.187189,.123539,.02245,.119429,.008118,.02        J   55
```

```
     34232,,01811,-.013313,-.020412,-.030545,-.061797,-.001826,.121471,.   J  56
     4064336,.081801,.056314,.055151,.067,.083684,.020131,.037683,.09235   J  57
     59,.018848,.00924,.00013,.023795,.007413,.103092,.167905,.004016,.0   J  58
     670316,.097868,-.000464,-.162078)                                     J  59
      DATA (EMT=.092394,.048995,.127138,-.02266,-.249166,.06975,-.087349   J  60
     1,-.154994,-.075775,.081004,-.035675,-.040077,.023167,-.115908,.107   J  61
     256,-.470139,-.166568,-.137278,-.366057,-.235691,-.029841,-.232583,   J  62
     3.015918,-.046104,-.045777,.024588,.037058,.062662,.100085,.001486,   J  63
     4-.214992,-.08885,-.138137,-.079156,-.07518,-.09377,-.136212,.01265   J  64
     52,-.041351,-.186534,-.014159,.001108,-.09774,-.025662,-.004717,-.1   J  65
     642748,-.983392,.000155,-.170839,-.2527,.24145,.983392)               J  66
      DATA (FMT=-.072171,-.158148,-.23102,-.012058,.190978,-.076755,.0646   J  67
     179,.109779,.038823,-.075341,.011294,.015287,-.027333,.062495,-.096   J  68
     2216,.403122,.10073,.074903,.267798,.169277,.021495,.16502,-.028903   J  69
     3,.035913,.040884,-.014177,-.022102,-.045831,-.06729,.001066,.14100   J  70
     47,.04968,.094743,.048085,.039534,.050998,.089176,-.032552,.017001,   J  71
     5.140729,.003867,-.004373,.058355,.010515,.000162,.067775,2.003205,   J  72
     6-.00155,.149654,.235294,-.623288,-2.003205)                          J  73
C                                                                          J  74
      NZERO=0                                                              J  75
C                                                                          J  76
      NUDF=IDEP                                                            J  77
      IF (NUDF) 3,5,1                                                      J  78
    1 IF (52-MT) 4,2,2                                                     J  79
C                                                                          J  80
    2   WUDF=IDEP                                                          J  82
      WUDM=WUDF*1.8288                                                     J  83
      WCOR=AMT(MT)+BMT(MT)*WUDM*CMT(MT)*1.E-04*(WUDM**2)*DMT(MT)*1.E-07*   J  84
     1(WUDM**3)*EMT(MT)*1.E-11*(WUDM**4)*FMT(MT)*1.E-15*(WUDM**5)          J  85
      WCDM=WUDM*WCOR                                                       J  86
      KCDM=WCDM*0.5                                                        J  87
      MTDC=WCOR*0.5                                                        J  88
      KCDF=(WCDM*0.54681)*0.5                                              J  89
      METUNC=WUDM                                                          J  90
      RETURN                                                               J  91
C                                                                          J  92
    3 PRINT 6                                                              J  93
      GO TO 5                                                              J  94
C                                                                          J  95
    4 PRINT 7                                                              J  96
C     ERROR EXIT                                                           J  97
    5 KCDM=NZERO                                                           J  98
      MTDC=NZERO                                                           J  99
      KCDF=NZERO                                                           J 100
      RETURN                                                               J 101
C                                                                          J 102
    6 FORMAT (1X,*DEPTH READ IS NEGATIVE*)                                 J 103
    7 FORMAT (1X,*MATTHEWS ZONE NUMBER IS GREATER THAN 52*)                J 104
      END
```

```
5,4DS     MTC0R

                                        IDENT     MTC0R

        PR0GRAM LENGTH              01015
        ENTRY P0INTS     MTC0R      00577
        EXTERNAL SYMB0LS
                         01010100
                         THEND.
                         0B0DICT,
                         STH.
           00074 SYMB0LS
```

```
      SUBROUTINE IGRF(DATE,ITYPE,ALT,COLAT,ELONG,X,Y,Z,T)                JS170700
CGENP   IGRF
C                                                                        JS170800
C  THIS SUBROUTINE COMPUTES VALUES OF X,Y,Z AND T FOR A GIVEN EPOCH      JS170900
C  AND POSITION FROM THE SPHERICAL HARMONIC COEFFICIENTS OF THE          JS171000
C  INTERNATIONAL GEOMAGNETIC REFERENCE FIELD                             JS171100
C  DATA  DATE = REQUIRED EPOCH IN YEARS AND DECIMALS OF A YEAR, A.D.     JS171200
C        ITYPE = 1 IF GEODETIC COORDINATES ARE BEING USED                JS171300
C        ITYPE = 2 IF GEOCENTRIC COORDINATES ARE BEING USED              JS171400
C          ALT = HEIGHT ABOVE MEAN SEA LEVEL IN KILOMETERS               JS171500
C          ALT = RADIAL DISTANCE FROM CENTRE OF EARTH IN KILOMETERS      JS171600
C        COLAT = COLATITUDE IN DEGREES (0.0 TO 180.0)                    JS171700
C        ELONG = EAST LONGITUDE IN DEGREES (0.0 TO 360.0)                JS171800
C  OUTPUT  X = NORTH COMPONENT OF MAGNETIC FORCE IN GAMMAS               JS171900
C          Y = EAST COMPONENT OF MAGNETIC FORCE IN GAMMAS                JS172000
C          Z = VERTICAL COMPONENT OF MAGNETIC FORCE IN GAMMAS            JS172100
C                                        (POSITIVE DOWNWARDS)            JS172200
C          T = TOTAL MAGNETIC FORCE IN GAMMAS                            JS172300
C  N.B. THE COORDINATE SYSTEM FOR X,Y AND Z IS THE SAME AS THAT          JS172400
C       SPECIFIED BY ITYPE                                               JS172500
      DIMENSION   P(44),Q(44),CL(8),SL(8),AGH(80),DGH(80)                JS172600
C  THE S.H.COEFFIEIENTS ARE SUPPLIED BY THE FOLLOWING DATA STATEMENTS    JS172700
C  ALTERNATIVELY, THE COEFICIENTS MAY BE SUPPLIED BY STATEMENTS OF       JS172800
C  THE FORM - AGH(1) = -30339, AGH(2) = -2123, ETC                       JS172900
C  OR THE COEFFICIENTS MAY BE READ IN THE MASTER PROGRAM AND MADE        JS173000
C  AVAILABLE TO THE SUBROUTINE BY A COMMON STATEMENT                     JS173100
C                                                                        JS173200
C  SET INITIAL VALUES                                                    JS173300
C                                                                        JS173400
      DATA (AGH = -30339.,-2123.,5758.,-1654.,2994.,-2006.,1567.,130.,   JS173600
     A1297.,-2036.,-403.,1269.,242.,843.,-176.,958.,805.,149.,492.,      JS173700
     B-280.,-392.,8.,256.,-269.,-223.,357.,16.,246.,125.,-26.,-123.,     JS173800
     C-161.,-107.,-51.,77.,47.,60.,-14.,4.,106.,-229.,68.,3.,-32.,-4.,   JS173900
     D-10.,-112.,-13.,71.,-54.,-57.,0.,-27.,12.,-8.,-25.,9.,-9.,23.,     JS174000
     E13.,-19.,-2.,-17.,10.,9.,3.,-3.,-13.,-12.,5.,-4.,-17.,7.,4.,-5.,   JS174100
     F22.,12.,-3.,6.,-16.)
      DATA (DGH = 15.3,8.7,-23,-24,4.0,3,-11.8,-1.6,-16.7,0.2,-10.8,     JS174200
     A4.2,0.7,0.7,-3.8,-7.7,-0.7,0.2,-0.1,-3.0,1.6,-0.1,2.9,-2.1,-4.2,   JS174300
     B1.9,1.1,2.3,2.9,1.7,0.6,-2.4,0.0,0.8,1.3,-0.3,-0.1,-0.3,-0.9,1.1,  JS174400
     C-0.4,1.9,2.0,-0.4,-1.1,-0.4,0.1,-0.2,0.9,-0.5,-0.3,-1.1,-0.7,0.3,  JS174500
     D-0.5,0.4,0.3,0.2,0.0,0.4,-0.2,0.2,-0.6,0.3,0.1,0.4,0.1,0.6,-0.2,   JS174600
     E0.0,-0.3,0.0,-0.2,-0.1,-0.3,0.3,-0.4,-0.3,-0.3,-0.5,-0.3)          JS174700
      T=DATE-1965.0                                                      JS177900
      R=ALT                                                              JS178000
      ONE=COLAT*0.0174533                                                JS178100
      SLAT=COS(ONE)                                                      JS178200
      CLAT=SIN(ONE)                                                      JS178300
      ONE=ELONG*0.0174533                                                JS178400
      CL(1)=COS(ONE)                                                     JS178500
      SL(1)=SIN(ONE)                                                     JS178600
      X=0.0                                                              JS178700
      Y=0.0                                                              JS178800
      Z=0.0                                                              JS178900
      CD=1.0                                                             JS179000
      SD=0.0                                                             JS179100
```

```
      L=1                                                                JS179200
      M=1                                                                JS179300
      N=0                                                                JS179400
      GO TO (1,2), ITYPE                                                 JS179500
C                                                                        JS179600
C  CONVERSION FROM GEODETIC TO GEOCENTRIC COORDINATES                    JS179700
C                                                                        JS179800
    1 A2=40680925.                                                       JS179900
      B2=40408585.                                                       JS180000
      ONE=A2*CLAT*CLAT                                                   JS180100
      TWO=B2*SLAT*SLAT                                                   JS180200
      THREE=ONE+TWO                                                      JS180300
      FOUR=SQRT(THREE)                                                   JS180400
      R=SQRT(ALT*(ALT+2.0*FOUR)+(A2*ONE+B2*TWO)/THREE)                   JS180500
      CD=(ALT+FOUR)/R                                                    JS180600
      SD=(A2-B2)/FOUR*SLAT*CLAT/R                                        JS180700
      ONE=SLAT                                                           JS180800
      SLAT=SLAT*CD-CLAT*SD                                               JS180900
      CLAT=CLAT*CD+ONE*SD                                                JS181000
C                                                                        JS181100
    2 RATIO=6371.2/R                                                     JS181200
C                                                                        JS181300
C  COMPUTATION OF SCHMIDT QUASI-NORMAL COEFFICIENTS P AND Q(=Q)          JS181400
C                                                                        JS181500
      P(1)=2.0*SLAT                                                      JS181600
      P(2)=2.0*CLAT                                                      JS181700
      P(3)=4.5*SLAT*SLAT-1.5                                             JS181800
      P(4)=5.1961524*CLAT*SLAT                                           JS181900
      Q(1)=-CLAT                                                         JS182000
      Q(2)=SLAT                                                          JS182100
      Q(3)=-3.0*CLAT*SLAT                                                JS182200
      Q(4)=1.7320508*(SLAT*SLAT-CLAT*CLAT)                               JS182300
      DO 15 K=1,44                                                       JS182400
      IF(N-M) 3,4,4                                                      JS182500
    3 M=0                                                                JS182600
      N=N+1                                                              JS182700
      RR=RATIO**(N+2)                                                    JS182800
      FN=N                                                               JS182900
    4 FM=M                                                               JS183000
      IF(K-5) 8,5,5                                                      JS183100
    5 IF(M-N) 7,6,7                                                      JS183200
    6 ONE=SQRT(1.0-0.5/FM)                                               JS183300
      J=K-N-1                                                            JS183400
      P(K)=(1.0+1.0/FM)*ONE*CLAT*P(J)                                    JS183500
      Q(K)=ONE*(CLAT*Q(J)+SLAT/FM*P(J))                                  JS183600
      SL(M)=SL(M-1)*CL(1)+CL(M-1)*SL(1)                                  JS183700
      CL(M)=CL(M-1)*CL(1)-SL(M-1)*SL(1)                                  JS183800
      GO TO 8                                                            JS183900
    7 ONE=SQRT(FN*FN-FM*FM)                                              JS184000
      TWO=SQRT((FN-1.0)**2-FM*FM)/ONE                                    JS184100
      THREE=(2.0*FN-1.0)/ONE                                             JS184200
      I=K-N                                                              JS184300
      J=K-2*N+1                                                          JS184400
      P(K)=(FN+1.0)*(THREE*SLAT/FN*P(I)-TWO/(FN-1.0)*P(J))               JS184500
      Q(K)=THREE*(SLAT*Q(I)-CLAT/FN*P(I))-TWO*Q(J)                       JS184600
C                                                                        JS184700
```

```
C  SYNTHESIS OF X,Y AND Z IN GEOCENTRIC COORDINATES                    JS184800
C                                                                     JS184900
    8 ONE=(AGH(L)+DGH(L)*T)*RR                                        JS185000
      IF(M) 10,9,10                                                   JS185100
    9 X=X+ONE*Q(K)                                                    JS185200
      Z=Z-ONE*P(K)                                                    JS185300
      L=L+1                                                           JS185400
      GO TO 14                                                        JS185500
   10 TWO=(AGH(L+1)+DGH(L+1)*T)*RR                                    JS185600
      THREE=ONE*CL(M)+TWO*SL(M)                                       JS185700
      X=X+THREE*Q(K)                                                  JS185800
      Z=Z-THREE*P(K)                                                  JS185900
      IF(CLAT) 12,12,11                                               JS186000
   11 Y=Y+(ONE*SL(M)-TWO*CL(M))*FM*P(K)/((FN+1.0)*CLAT)               JS186100
      GO TO 13                                                        JS186200
   12 Y=Y+(ONE*SL(M)-TWO*CL(M))*Q(K)*SLAT                             JS186300
   13 L=L+2                                                           JS186400
   14 M=M+1                                                           JS186500
   15 CONTINUE                                                        JS186600
C                                                                     JS186700
C  CONVERSION TO COORDINATE SYSTEM SPECIFIED BY ITYPE                 JS186800
C                                                                     JS186900
      ONE=X                                                           JS187000
      X=X*CD+Z*SD                                                     JS187100
      Z=Z*CD-ONE*SD                                                   JS187200
      T=SQRT(X*X+Y*Y+Z*Z)                                             JS187300
C                                                                     JS187400
      RETURN                                                          JS187500
C                                                                     JS187600
C  LIBRARY FUNCTIONS USED BY THIS SUBROUTINE ARE SIN,COS,SQRT         JS187700
C                                                                     JS187800
C  SAMPLE RESULTS                                                     JS187900
C  IGRF(1965,0,1,0.0,0.0,30,0,2541.,-240.,56349.,56407.)              JS188000
C  IGRF(1965,0,1,0.0,180.0,295.0,12923.,9661.,-56900.,59144.)         JS188100
C  IGRF(1969,3,1,0.0,57.0,195.0,25092.,5729.,30145.,39638.)           JS188200
C  IGRF(1965,0,2,6371.2,45.0,10.0,21848.,-1052.,40417.,45956.)        JS188300
C  IGRF(1967,5,2,9000.0,31.0,359.0,5750.,-1226.,17853.,18796.)        JS188400
C                                                                     JS188500
      END                                                             JS188600
```

```
5,4DS       IGRF

                                                IDENT      IGRF

        PROGRAM LENGTH                  01266
        ENTRY POINTS     IGRF           00413
        EXTERNAL SYMBOLS
                         02007110
                         080DICT.
                         SQRTF
                         SINF
                         COSF
            00163 SYMBOLS

LOAD
RUN,60,9500
```